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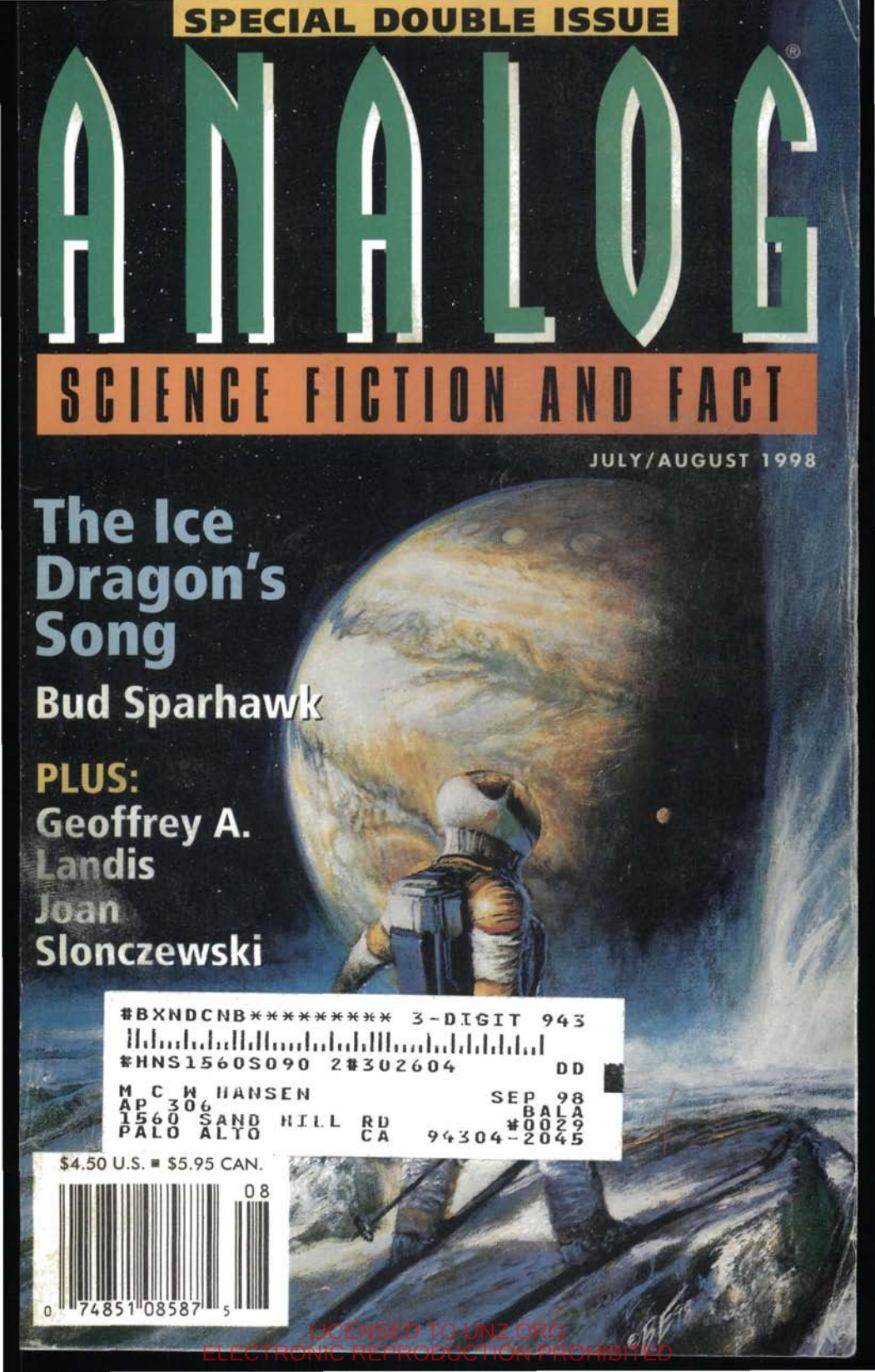

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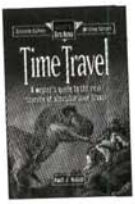

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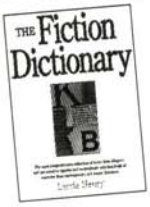

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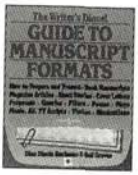

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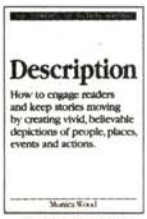
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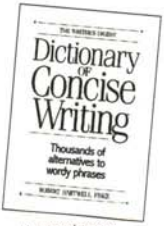

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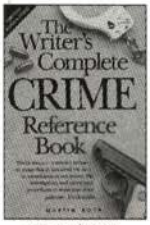

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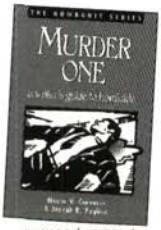

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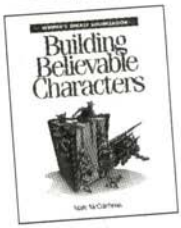

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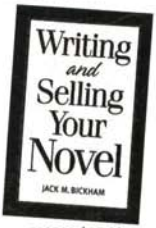

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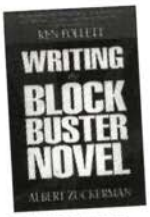

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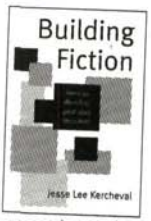

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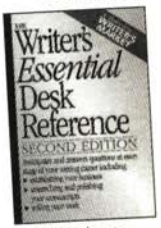

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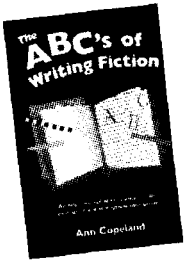

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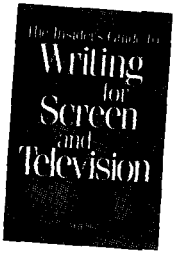

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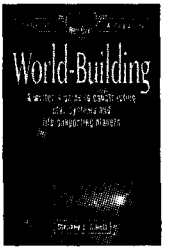

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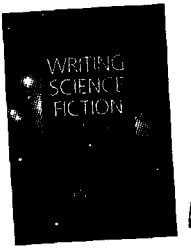

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Next Issue on Sale
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Serial

THE CHILDREN STAR (Conclusion),
Joan Slonczewski ____ 180

Novellas

THE ICE DRAGON'S SONG, Bud Sparhawk ____ 12
SLOW DROWNING, Daniel Hatch ____ 106

Novelette

A LIFE ON MARS, G. David Nordley ____ 68

Science Fact

PATHFINDER JOURNAL: ADVENTURES IN THE MARS BUSINESS,
Geoffrey A. Landis ____ 46

Short Stories

MOON-CALF, Stephen Baxter ____ 146
THE LONG WAY HOME, Shane Tourtellotte ____ 158
IN SPACE, NO ONE CAN HEAR, Michael A. Burstein ____ 166

Probability Zero

EFFACING THE TRUTH, Arlan Andrews ____ 66

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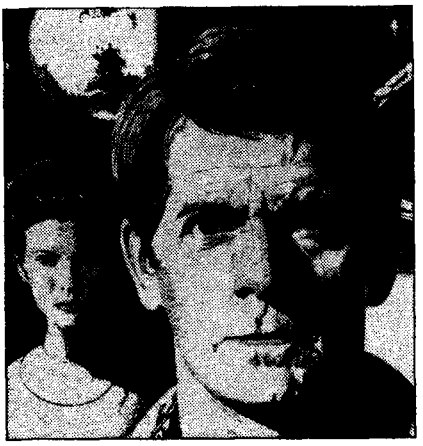

68

Poetry

SONNET ON FIRST LEARNING THE DEFINITIVE ROLE OF NEUROTRANSMITTERS IN THE DETERMINATION OF HUMAN EMOTIONS, Eliot Fintushel ____ 223

Special Feature

SCIENCE FICTION AROUND THE WORLD, James Gunn ____ 92

THAT INVINCIBLE HUMAN SPIRIT, OR, THE GOLDEN SHIPS, Alexandr Kramer ____ 97

IKAROS, Erik Simon ____ 101

Reader's Departments

THE EDITOR'S PAGE ____ 4

THE ALTERNATE VIEW, Jeffery D. Kooistra ____ 154

IN TIMES TO COME ____ 179

THE REFERENCE LIBRARY, Tom Easton ____ 224

ANALYTICAL LABORATORY RESULTS ____ 230

BRASS TACKS ____ 232

UPCOMING EVENTS, Anthony Lewis ____ 240

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Indicia on Page 5

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KING OF THE HILL (NO MATTER WHAT)

Over the years I've heard a great many solemn discussions about "What sets Man apart from the lower animals." After considerable reflection, I've decided that one of the most promising candidates for an answer is, "The fierce determination to believe that there is something that sets Man apart from the lower animals, no matter what it takes to maintain that belief."

This observation is not, of course, entirely original. Sue Savage-Rumbaugh and Roger Lewin give an eloquent account of the history of human determination to view our species as something apart from (and above) the rest of nature in their book *Kanzi: The Ape at the Brink of the Human Mind* (Wiley, 1994). I don't have room to tell the whole story here (though I strongly recommend that you read at least the first chapter [after which you'll probably want to read the rest]), but the highlights are simple enough.

In the beginning was a religiously dominated world-view that took it as an article of faith that Man was, in Mark Twain's words, "the Creator's pet." But even the early evolutionists (and some much later ones) explicitly considered humankind to have several characteristics that were unique—not just quantitatively, but qualitatively different from anything possessed by any other animal. These included language, the using and making of tools, consciousness of self, and culture (broadly defined as the transmission of learned behavior from generation to generation).

During the last few decades, all of these supposedly distinct barriers have been challenged by new observations. Jane Goodall took the unprecedented step of actually watching wild chimpanzees going about their business over long periods, instead of jumping to broad conclusions from a few glimpses, and found clear examples of tool use; many others have been seen since then. Gordon Gallup found that chimps clearly did recognize mirror images as reflections of themselves. Numerous investigators including Savage-Rumbaugh herself (working with bonobos [sometimes called "pigmy chimps"]), and others such as Penny Patterson working with gorillas and Lou Herman with dolphins, have found other animals capable of startlingly sophisticated use of language.

Or so *they* claimed. You might think that such discoveries would be greeted with profound excitement by the discoverers' colleagues, but such has not generally been the case. In practice, the commonest responses to the announcement of new discoveries suggesting that "lower" animals did something previously thought to be exclusively the province of man included extraordinary skepticism, often followed by redefining the activity so that man still qualified and other animals didn't.

For example, when some experimenters claimed that chimps and gorillas

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had learned sizable vocabularies of symbols and combined them in new ways to communicate with their human associates, other researchers said, "Can't be. They're just mimicking or picking up nonverbal cues from the experimenter." Never mind that what the apes were doing would have been unquestioningly accepted as communication if humans did the same thing. These were "animals," therefore they couldn't really be communicating and what they were doing was "mere mimicry" or "the Clever Hans Effect," even if we had to redefine communication to make it so. A fascinatingly ironic twist on this kind of thinking came when Sue Savage-Rumbaugh had occasion to try teaching retarded humans with the same methods she had earlier used with bonobos—and obtained virtually identical results. (See Chapter 7 of *Kanzi*.)

I must emphasize that the kind of resistance I'm talking about is not simply the routine skepticism that is one of the cornerstones of all good science. Any experimental results, especially if they appear to contradict reasonable expectations, *should* be scrutinized quite closely and held to rigorous standards of proof. Much of the criticism of animal language and other behavioral studies seems to go far beyond that, assuming *a priori* that certain results are so impossible that any appearance of them *must* be due to something else. That is not good science—and it will affect the results of any research done with intelligent beings. (I discussed this phenomenon at considerable length in my December 1980 editorial, "Self-Fulfilling Prophecies.")

It seems that a great many people, including quite a few working scientists, have deeply ingrained in their thinking the presumption that there is a firm, absolute boundary between humans and "animals." They apparently feel threatened by any suggestion that that boundary is not as firm or absolute as they thought, and instinctively assume a defensive posture against any such threat. "In one way or another," says anthropologist Matt Cartmill, quoted in *Kanzi*, "policing and maintaining that boundary has been a tacit objective of most paleoanthropological model-building since the late 1940s." The basic strategy for that policing seems to be: first try all possible justifications for not admitting anything else into the fraternity of Those Who Can Do Human Things, and if that fails, change the qualifications.

And now we have a new upstart on the playing field: a "lower animal" of our own invention. Science fiction readers have long been familiar with debates over, "Can a machine be intelligent?" Personally, I've always been amazed and fascinated by the number of people who respond, quite positively and so promptly that they can hardly have given the matter much thought, "Obviously not! A machine cannot think; it can only do what it's been programmed to do."

Now, far be it from me to claim that *everybody* who has reached that

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conclusion has done so without a great deal of high-quality thought, or even that the conclusion is necessarily wrong. It may well be that there is some fundamental reason that human-built machines cannot think in some sense that humans can. All I can say with authority is that I personally have not yet seen such an argument that I found compelling. And I have observed a history of people saying, "Computers will never be able to do A, and that proves that they can't really think"; and then when computers do do A, the same people say, "Well, computers will never be able to do *B*. . . ."

We used to hear, for example, that a computer would never be able to beat a human Grand Master in chess. After it happened, we would hear mumblings of, "A computer will never be able to write music that sounds like *real* music. . . ." Yet *The New York Times*, as long ago as November 1997, carried a long article about a computer that did exactly that. An audience listened to the same pianist play three unidentified compositions: one by Johann Sebastian Bach, one by a professional musicologist imitating the style of Bach, and one by a computer program called EMI (Experiments in Musical Intelligence). Asked to say which was which, the audience thought the piece by the musicologist was by the computer, and the piece by the computer was by Bach.

It seems a clear musical version of the Turing Test, in which a machine is to be deemed intelligent if it can carry on a conversation which leads a human to think it is human. Yet many of the reactions were not along the lines, "What an impressive program!," but more like, "How appalling!" The musicologist-pianist found it "very disconcerting" that people could be "duped by a computer program." Douglas Hofstadter, the cognitive scientist who ran the composition contest (and wrote the Pulitzer-Prize-winning book *Gödel, Escher, Bach*), found himself "baffled and troubled" by the experiment, thinking it suggested that, "Music is much less than I ever thought it was."

But does it? I don't think so—but it may mean that something else is much *more* than he ever thought. Why should that be frightening? Music remains, quite demonstrably, a powerful way to touch and move human beings. Any human being who can create music that does that has made an impressive and commendable accomplishment. Why should not the same be true, and calmly acknowledged to be true, of a machine that can do the same—or a programmer who can make a machine do the same?

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True, the computer didn't do it the same way a human would do it. It did not experience life and then create music that evoked in a listener the same feelings that experience evoked in itself. But does that matter, if it evokes feelings that *could* be evoked by experience? I'm inclined to agree with Dr. David Cope, the composer-programmer who created EMI, who observes, "When I am camping in the Sierras there is an incredible beauty I see. But it is unintended by nature. The plants are not trying to express things to me and the mountain is not trying to communicate. But I'm inspired anyway."

The headline on the continuation of the *Times* article seems to miss that point. It says, "Undiscovered Bach? No, a Mere Computer Program Is the Composer." I say that a computer program that can pass itself off as Bach is far from "mere." How much of the credit should go to the program and how much to the programmers is a subject for another debate; the important point for now is that if human listeners judge the program's output comparable in value to that of Bach, then it *is* comparable to Bach—and that neither diminishes Bach's accomplishment nor threatens the humanity of any of us. It's just another route to a similar end. (And those who insist on feeling threatened but console themselves by saying, "Well, it's not very *good* Bach!" are missing another important point, the one I call the "primitive machine" effect: if our machines can do it this well now, they'll be able to do it better later.)

What fascinates me most in all this is not whether either animals or machines can do things that humans have always thought of as exclusively their own. (My own working answer to that is: "Sure! Why not, and so what?") What fascinates me is why so many of us have such a powerful, knee-jerk need to believe that the answer is *no*. I haven't convinced myself that I know the answer, or at least the whole answer, but I can make some partial speculations that may help point someone in a fruitful direction.

First, I think the answers are at least somewhat different for machines and animals—though not as different as they might first seem. For machines, I think, it's pretty obvious that people feel threatened by the idea that something else might someday be able to do their jobs, or even rule their lives. Change is almost always inconvenient, and most people would rather maintain the status quo, even if they're not terribly happy with it, than take on the risks of making a transition to something new—even if what's beyond the transition might be better. Not many humans can see as far as, say, Joan Slonczewski, who has shown us a future in which "sentients" work alongside humans as equals.

With animals, the situation is a little different. Through our entire history we have become accustomed to pushing them around in ways dictated by our own wants and needs without much regard for theirs. Many of us, consciously or un, would just as soon keep it that way; and admitting that other animals were closer to our equals than we've assumed would make that harder. As Savage-Rumbaugh and Lewin suggest, with direct reference to animal intelligence experiments, "Man's ability to exploit the planet, to take of its resources as he needs, and to usurp entire forests and all living creatures therein, rests upon the unwritten assumption that the chasm between himself and all other creatures is impassable. All of modern man's activities operate from the premise that the planet is his to allot into countries, states, counties, and individual plots, because he, unlike other creatures, has been given the twin gifts of reason and expression. By assuming that other animals lack these gifts entirely, man obviates any need to listen to the wishes of the creatures with which he shares the planet. He can therefore proceed comfortably by his own lights, blind to information that is perceived as nonexistent."

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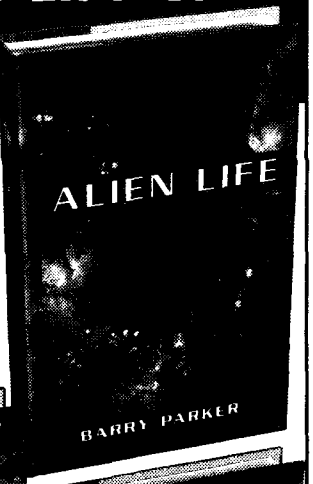

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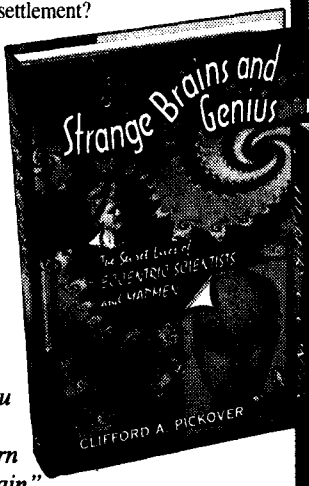

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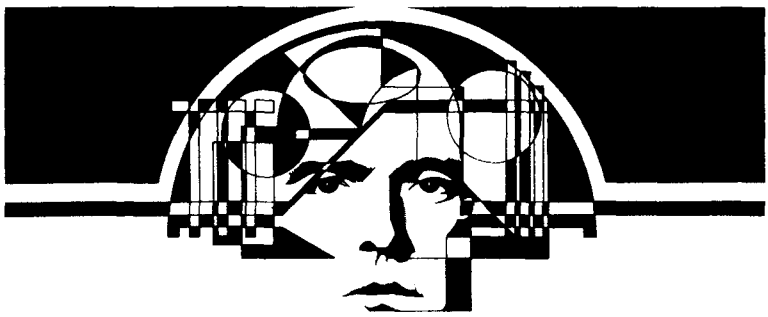
Ultimately, though, that, too, comes back to a fear of fundamental change. It seems to me that many of us, even scientists, feel so threatened by any talk of animal or machine intelligence because admitting such a thing would probably necessitate profound changes in the way we live and relate to everything else.

And what do such views say about our ability to interact with aliens who are more advanced or better-equipped? Savage-Rumbaugh and Lewin talk about our attitude toward "dominion over the Earth"; what will happen if and when we meet, here or there, beings who have evolved similar attitudes toward their own home planets? The reactions to animal and machine intelligence studies I have seen so far suggest that we need some serious attitude adjustments before we're ready for that.

We hear a lot about "self-esteem" these days. Many educational systems have taken to viewing it as an intrinsic good and an inherent right, trying to help students to have it whether they're very good at things or not. But maybe it's time to get back to regarding self-esteem as something to be earned, and earned on the basis of your own virtues and accomplishments rather than somebody else's inferiority.

And maybe it's time that we as a species worked on the ability to respect ourselves on some terms other than being better than everybody and everything else. After all, few individual human beings can enjoy that luxury; probably few species can, either, and it's time we started outgrowing the perceived need for it.■



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Bud Sparhawk

The Ice Dragon's Song

Sometimes chance gives us more opportunity than we really wanted. . . .

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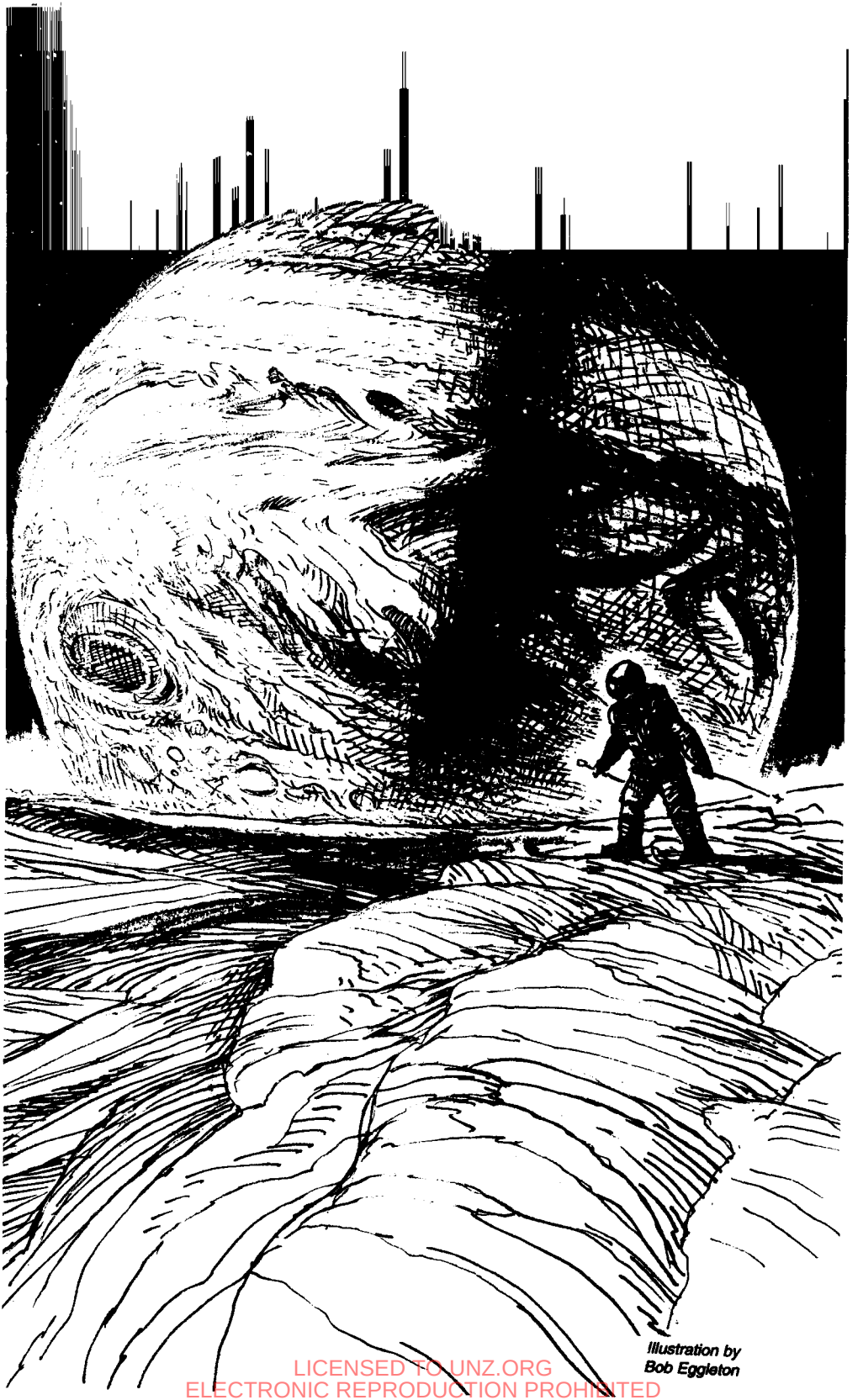

Illustration by Bob Eggleton

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The monstrous snow snake roared past Paul Levin at fantastic speed, leaving a falling mist of slush and ice behind. The mist was so dense that he couldn't even see giant Jupiter's rosy form above the horizon.

The habitat could only be a few hundred meters further, Paul thought. He cautiously skied ahead, probing the ice with the tip of his ski before transferring his weight forward.

Suddenly a massive jolt shook the ice pack. He was violently thrown off his feet and tossed about. It felt as if all of Europa had shifted beneath him. He was terrified as the surface continued to tremble. Paul didn't know whether he was going to live or die as the tremors continued.

It was only yesterday that he had been climbing the ladder to the cab of his father's harvester. From that vantage he saw four sets of snow snakes leaping near the horizon, five or six kilometers away. They were backlit by Jupiter's ruddy glow. The snakes were particularly active today, he thought, throwing their coils high into Europa's tenuous atmosphere. Four snakes at one time were far more than usual.

From their position Paul estimated that they had to be erupting from the minor cracks that branched from the thick width of the main Sarpedon Linea, the fissure the Levins had drawn for harvesting.

Paul knew that they weren't really snow snakes. They were really the plumes from the linear geysers that routinely spewed up gases, soft ice, and particulate matter from Europa's core. They were just slush thrown up as some ice floes were squeezed together by Jupiter's massive gravitational effect.

Still, he wished that the snow snakes he'd fantasized about when he was younger had been real. That would have made this hideous dead moon a place more alive, more like somewhere a human being could live comfortably.

Paul squeezed though the harvester cab's narrow opening. The opening was barely wide enough to allow his bulky suit to clear the frame. He settled into the hard seat before the console. Through the thick insulation of his gloves he could feel Europa's angry song as the harvester tore at her skin, peeling away the dross of silicates to expose her pristine white skin beneath. It was a slow dirge that rang in his helmet, but so soft that he had to strain to hear it at all. For a moment he allowed himself to be immersed in the counterpoint of the harvester's mechanical beat and the moon's slow song.

"Paul, have you adjusted the blade depth yet?" The voice of his father startled him. Damn, just like his father to catch him daydreaming again!

"Working on it right now, Dad," he replied and started to crank the big wheel near his right side. About twenty turns, his father had instructed him, then he was to wait a minute and check the harvester's feed rate. Paul waited and then did so, and waited still another minute to be certain that he had gotten the blade adjusted properly. He wanted to make certain that it met his father's strict standards so he wouldn't get yelled at again.

The feed rate was a measure of the depth the harvester's blade bit into the thin topmost crust of Europa's soft ice. The deep geysers that erupted from the major lineae, such as Sarpedon, were rich in particulates and minerals that JBI industries wanted, particularly the various forms of corundums—mostly rubies and sapphires—and an occasional diamond.

If the blade bit too deeply the particulate layer that the harvester scooped from the surface would be diluted by too much slush, which would overload the processors. Set it too shallow and the harvester would leave too much of the layer behind. Only by having the blade adjusted correctly to the layer the harvesters were passing through could they make JBI's quota. The layer was so

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variable that the harvesters required constant attention, which meant long hours working the string back and forth.

His father usually did this alone, but with the break in classes Paul was able to help out and relieve the family of some of the neverending labor.

He checked the feed rate again, turned the wheel back a few turns, waited, and then looked at the feed rate once more. He'd learned a long time ago that he had to check everything he did for his father at least three times to be absolutely sure. His father was only interested in perfection—anything less was failure in his eyes. He wondered if Vincent, his brother, had faced the same demanding criticism before he finally left home.

His father's approval was particularly important today, because Paul was going to ask for his permission to enter the big Aphrodite race next month, the race that would show everyone that Paul wasn't a kid anymore, that he could run the ice as well as anyone.

"Pee, why aren't you done yet?" his father barked impatiently over the laser link. "I thought you knew how to set a blade."

"I do, Dad, but I . . ."

"If you're finished then get over to the next one," his father barked. "We need to get all of these set right before dinner!" Paul cringed at the disapproving tone of his father's voice and knew that he'd screwed up again.

It was so unfair, he thought as he climbed down and put on his skis. He was just trying to do things right.

Much later, after Paul finished adjusting the last harvester in the line, he climbed down and headed across the ice fields, pushing one ski ahead of the other in a steady, efficient, distance-consuming rhythm. His ears filled with Europa's song as the broad skis alternately compressed the coarse-grained ice. Here in the softer ice on the fringe of Sarpedon, her song was gentle, serenading him as he headed for the family's hab.

When he had first asked about the singing that pervaded every movement of the hab across the ice, and that reverberated in his suit whenever he skied, his mother had replied that the songs were the dragons' cries, ancient legends that they sang from their caverns far below the ice. Only the strongest and best songs reached the surface, she declared, so he must listen closely and try to understand their deeper meaning.

His mother had tried to make this place acceptable to his young mind. At nights, as they huddled in the tiny habitat, she would tell him fanciful tales of the denizens of the deep oceans within Europa, of the dragons that ate stone and spat diamonds, of snow snakes that leaped in Jupiter's light. She would weave tales of the deep forests of silicon trees and calcinate grasses, speaking of vales and meadows of metallic weeds. With her words Europa changed from a dead, frozen wilderness into a place more rich and strange. With her tales Europa had become a place of wonder.

Of course *now* he knew that the mythical dragons beneath his feet weren't really singing. He now knew that the song was just an effect caused by the compression of the ice, the pressure of his passage momentarily boiling the thin shell of liquid that surrounded each uniform, icy grain. It was the same effect that caused the singing and booming sands on the distant Earth that he would probably never see again, thanks to his father's decision to exile them to this cold and horrid world.

The continual deep song of Europa was caused by the violent compression of floe against floe, of one continent-sized mass against another. As they ground in opposition, the vibrations thundered to the surface, there to be dissipated by the covering of snow and ice.

When the song changed, Paul knew that he had crossed over from the coarse to the fine-grained, nearly solid

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ice of the Cadmus region—the older glacial formation through which the Sarpedon crack ran.

The smoother, more compressed ice grains allowed Paul to ski along at a faster rate. Push, slide, push, slide, push, slide; he fell into an easy rhythm, careful not to exert too much downward pressure against the ice. He'd done that too often when he was first learning how to propel himself across Europa's endless ice fields and had paid the price with embarrassed pratfalls. Since Europa's surface gravity was only a fraction of Earth's it was all too easy to launch yourself right off the ice—and pay the price by landing on various anatomical elements, none of which were padded with dignity.

The harvesters were now passing through an unusually level section of Cadmus, which meant that he didn't have to work his way up and down the ubiquitous pressure ridges that dominated the landscape elsewhere. He spotted his family's hab just a short distance away and stroked toward it, lessening the distance with each bar of Europa's song.

He noticed that his mother had once again let the mobile hab draw closer to the Sarpedon fault, which probably meant that his father would raise hell with her when he got back. Safety was such a big thing that steering the hab too close to Sarpedon's instability was a sure way to raise his ire, just like that crap about having the emergency gear lying out all the time! As far as Paul was concerned all that safety gear took up too much of the severely limited living space inside. Still, his father always got his way, and his mother went along with whatever he said.

Paul hoped that he could correct the hab's drift before his father noticed. No sense listening to his safety-conscious father berate his mother yet again.

"Rough day, today," Abraham Levin reported as the three of them sat in the tiny galley, eating their evening meal. "Noticed there's a lot of variation in the particulate layers—seeing mostly tan stuff instead of the brown."

"You've got good eyes," Paul's mother, Sophia, replied as she wiped at her eyes. She was always rubbing at them because of the fumes at the assay bench. "The daily samples show that all we're getting are silicates, not much in the way of metallics at all, and nearly no corundum particles."

His father nodded. "I assume the volatiles have all boiled off as well?" As Sophia slowly nodded agreement, Abraham continued; "Just our damned luck to draw another worthless section of Sarpedon. Why couldn't we draw a rich section and get ahead of the game, just for once?"

"Now Abraham . . ." Paul's mother put out a consoling hand and rested it on her husband's shoulder. "We'll get lucky some day. God always rewards hard work."

Abraham jerked back as if struck. "Don't preach to me about God's rewards, Sophia. Not today! If God gave out rewards, I wouldn't be busting my ass out here on this frigid whore's tit of a forsaken moon where nobody can ever tell me which direction to send my prayers."

Paul watched his mother's face fall, as she blinked back her tears at the harsh rebuke. Paul was about to say something, *anything*, to change the subject when his father put an arm around her waist.

"I'm sorry, Sofia," he said. "It's been a hard day out there and I'm in a bad mood. I shouldn't take it out on you. Forgive me?"

Paul seethed. It was just like his father to manipulate his mother. He knew how to keep her under his control.

"Of course I do," his mother said softly and she pressed against her husband. "After all, it is my fault we are here—don't blame yourself for my sins." Sophia gave him a quick kiss on the

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cheek and then tweaked Paul's cheek between her thumb and forefinger. "But, Abraham, I wish you'd watch your language with the little one here."

Paul pulled away as much as he could in the tight space of the galley. He wished his mother wouldn't treat him like such a kid—next week he was going to be fourteen, hardly a baby anymore. "Aw, Mom . . ." he began.

"Hush!" his father said suddenly, putting up a hand to silence them.

Paul listened. All he could hear was the creaking of the hab's tractors as they pulled the hab slowly across the ice, the whirling and clicking of the various life-support machinery, and the constant hiss of the environmental unit. After a day of working in the noisy suit, the hab was practically a sea of calm silence. What had gotten Dad's attention? What had he heard?

Then Paul listened to Europa, the never-ending song that permeated everything. It was so constant that he'd stopped hearing it after a while—stopped being aware of its constant presence beneath the overlying mechanical noise.

Until it changed.

"What do you think is happening?" his mother whispered. "Are we in danger?" Europa's mid-range song had fallen half an octave and now possessed a deeper, richer quality.

"I don't think so," his father replied. "But I've never heard her sing this deep before. Something must be happening down below."

Down below! The words fired Paul's imagination as he tried to picture what could be occurring far beneath their hab, down below the fifty-kilometer-thick crust of Cadmus, the crust that lay over the incredible liquid oceans of this world. Was it possible that mysterious creatures swam in seas dark beyond comprehension down below? Was it possible that somewhere down there dwelt life forms strange beyond imagination, with biologies bizarre and varied? Could there really be dragons subsisting on wisps of sulfur, perhaps with skeletons of silicon, and skins of glistening jewels in place of scales? Could it be that when the dragons moved they shook the world and changed Europa's song?

He dismissed the thought. Such dreams were childish fantasies of a moon more alive than this proved to be. He had discarded such fantasies long before. The change was probably just another shifting of the floes.

"It's probably nothing." His father confirmed Paul's own thoughts. The words brought Paul's mind back to the present, back to the tiny galley, the constraining embraces of his too-familiar family.

"We need to get those assays uplinked by Greeley." Abraham changed the subject abruptly. "I'll put the weekly reports together. JBI should be satisfied with the progress of our harvester string this past week despite the poor assay—we've made twenty kilometers, that's four over schedule. We can send the samples down to Simon to take with him on next week's run to Marcus."

"That's a long time to wait for . . ." Mom said brightly with a quick sideways glance at Paul. "Could we ask Simon to make the trip earlier and pick, uh, *it* up?"

"I don't think . . ." his father began to protest, with a quick glance at Paul.

"I could make the run," Paul volunteered quickly. "I could get the samples there quicker. I know how to drive the scooter, and I could follow the Wholephore link there and back, and it's only a day's drive each way, and could I, Dad? Could I do that?" he said without pausing for breath, so intense was his desire.

"No!" his mother said at once. "You are still too young to make such a long drive. There's no telling what could happen to you on the way."

"Yes," his father said with a rare hint of a smile barely glimpsed beneath the corners of his mustache. "You're so young and full of fresh meat that the

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ice dragons might get you if you aren't careful."

Paul felt his face grow red. His father had always kidded him about his belief in the dragons when he was younger. Paul could remember overhearing him complaining to his mother for filling his son's head with such nonsense when he was trying to instill some sense of survival into the boy. Did he bring it up now just to remind Paul that he was still just a child?

"Your mother is right," his father continued, heedless of Paul's embarrassment. "You're still too young. I'll ask Simon to go ahead of schedule, Sofia."

Paul shrank back, his hopes disappearing like an ice fault flexus during sunside. It was obvious that neither of his parents was in a mood to discuss him entering the race. If Mom wouldn't let him drive the scooter to Marcus Station then there was no way she would let him enter the race—no way at all! Maybe when he was alone with his father, he could ask, man-to-man. It would have to be later, when they were away from his mother's overly protective influence.

"I want you to run an errand for me," his father said casually the next morning, during breakfast.

Paul's heart jumped. For a moment he hoped that his mother had relented during the night and they were going to let him take the scooter to Marcus after all. But his hopes were dashed with his father's next words.

"I want you to run our weekly report over to Simon at Greeley station. Make sure that he knows he has to transmit it right away."

Paul felt a rush of excitement. It wasn't a run to Marcus, but just being out there on the ice with the scooter would be great fun.

"Oh yes," his father added as Paul got up from his seat to find his suit. "I'll need the scooter this morning so you'll have to ski over. Be sure to put a reserve pack on your suit—don't want you to get caught out there without backup."

Paul fumed. He was old enough to be able to take care of himself. He didn't need to be reminded to take routine safety precautions, like some dumb kid. Not using the scooter was disappointing, but Greeley was only twenty klicks away—practically next door—and well within range of his normal suit's twelve hour air and power supply.

He was still seething over both his father's unnecessary safety reminder and the lack of scooter as he struggled to position the massive life-support pack onto his shoulders, straining his arms to jockey the thing onto the hangers at the back of his suit. He wished that he had a better build and more muscles. His brother, Vincent, had taken after their father in that respect. Vincent had his father's thick body and large hands while the slender and wiry Paul had inherited his mother's physique. He was strong for his size, but relative strength didn't seem to matter that much when you had to horse around something as bulky and massive as a suit pack with the reserve unit attached.

The pack finally slipped into place and connected with a loud clang that reverberated in his helmet. He listened to the smaller connectors clicking as they automatically locked the recycler, air supply, power, and scrubber units into place. He shifted his boots to find his balance. The extra mass of the reserve pack added half again the mass and made him somewhat back-heavy.

Paul moved through the hatch, unshipped his skis from their rack, and stepped outside. He could see Jupiter's rosy edge peeking over the western horizon. In a few weeks he'd be able to see more of the giant planet as their harvester string approached the meridian. With a rotation rate of three and a half days and Europa taking the same time to revolve around Jupiter, one side of the moon was always facing the planet.

He put the skis down on the ice at the

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edge of the hab's ramp and snapped his boots into the toe clamps. Leaning forward, he slid the skis back and forth to cool them down before shoving off. If you weren't careful about doing that you could easily melt into the soft ice and catch a tip when you skied forward. Cooling the skis was another trick he'd learned the hard way, much to the amusement of his older brother, who never seemed to make mistakes. Satisfied that he was ready to go, he pushed off and began striding away from the hab.

His anger quickly subsided as he fell into the smooth rhythm of the skis. His father *had* been letting him do more than usual this time he came home from school. Working alongside him on the harvester string was a big advance. Vince hadn't been allowed to do that until he was a year older than Paul was now. And taking the trip to Greeley and the drill rig was a new responsibility.

Greeley hab was located about twenty kilometers directly ahead. It served as one of the beacons for steering the harvester lines along Sarpedon. Although it was too faint for him to see, he could imagine the pencil-thin, blue-green navigational beam that linked the controlling harvester to Greeley. When the geysers were really active and provided a slight atmospheric mist, he could see the link's brilliant line shining in the perpetual twilight. His father, and the other harvester operators, paid a portion of their profit to Greeley for this navigational service.

The Richards, who operated Greeley, were relatively new to Europa, which was why they had the uninteresting job of maintaining the navigational hab. After a few years they could earn enough credits to qualify for a JBI loan, get a harvester string of their own, and start to earn their way to a better life.

Visiting the Richards' place would be a treat for Paul, for it would give him an opportunity to be with their daughter, Dolores, who, in his humble opinion, was the most beautiful, charming, and intelligent creature that God had ever created.

But he couldn't go directly to Greeley, which was probably why his father had wanted him to take the extra pack. Instead he had to deliver a package from his mother to the drill operators twenty kilometers to the west. "They deserve some home cooking," she had said with a smile. "Give them these cookies for me."

The drillers were melting a new bore hole to power some sort of scientific station JBI was going to move to that location. The bore would feed the Patterson cells that provided power for the station. With a ready source of water they wouldn't have to switch power units every week like the harvesters.

Paul fell into a steady rhythm as he moved along, occasionally varying his movements to impart changes onto the song of the ice. When his father's hab disappeared behind him all he could see was the ice, the stars, and Jupiter's gigantic presence peering above the horizon. A few of the smallest snow snakes accompanied him, criss-crossing his path as they followed the tiny lineae that marked minor fractures in the floes. The smaller regions of the ice were in constant motion even as the larger floes, nearly continental in size, drifted against one another with glacial force. Europa rearranged her topography more rapidly than Earth did its continents, but the principles were the same.

Soon Paul saw the tall tower of the drill. He didn't relish the idea of stopping at the station. The men at the bore were rough sorts—they'd been prospectors, they said, until they got a call from JBI to do some contract drilling. The two of them had stopped to call on his father when they passed the harvester string several weeks before. The tall one was named Jack. Rob was the short, kidding one. There was a hint of menace in their eyes and Paul didn't like the way that Rob looked at his mother.

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When he drew closer Paul noticed that the bore tower was canted from the vertical. The tilt was just enough to be noticeable. He momentarily wondered if something might be wrong as he headed toward the tiny hab next to the tower.

"Something big hit 'er during the night," Jack told him as they shared some warm tea with him over the opened pack of cookies. Snickerdoodles, his mother called the tiny disks.

"Ice dragons did it," Rob spat knowingly. "Something big moving around down there," he pointed at the floor. "Really big, too!"

"More likely it was just a floe shift," Jack continued, dismissing Rob's sarcasm. "I think our shaft got caught between two shifting masses."

Paul nodded toward the hatch. "I didn't see any shift in the ice cap out there. I thought Cadmus was a solid ice shield all the way down."

Both of the ex-prospectors laughed. "I wasn't talking about these little bitsy pressure floes you see on the surface. Hell, they don't matter at all! No, kid, down under the calm surface you see are the major floes, almost like continents. When they move there's a lot of energy involved."

Then Rob added, "That's where the ice dragons live, down there in the dark below." He was so serious that Paul took a minute before he realized that Rob was pulling his leg. But how had the man known of his mother's fantasy, of his own childish beliefs?

"Could that be why the song changed last night?" Paul asked, ignoring the bait.

"What the hell are you talking about, kid?" Rob said abruptly. "What 'song'?"

Paul carefully explained the shift his family had heard. "But my father says it's nothing to worry about," he ended.

Jack rubbed his chin in thought. "Might be. For sure, something big is happening down there and I'm pretty sure that we're right on the edge of it. No way of telling whether it's going to bring us good or not. Maybe we'll hit bottom soon and be able to get away from here."

"Or maybe we'll tap into a thermal upwelling," Rob said. "A nice mineral well—lots of ways we could get lucky on this."

Paul considered their words for a moment and realized the note of concern beneath their bantering. Both Jack and Rob were worried, but were trying hard not to show it. "You don't think there's any danger, do you?" What if something happened to his mother, his father, and the rest of the people who were in the area?

"Danger?" Rob laughed. "Listen, kid, we're sitting on a frigid ice planet with almost no atmosphere. You're sitting right over one of the major floes and right next to one of the biggest cracks on Europa's surface. Of course there's danger, but more from our own failures than the moon's. Think about it, kid: If we lose power, lose our air, if our recycler breaks down, or one of the other dozen things we depend on fails, we'll die. What's a moonquake or two compared to that?"

Paul had no answer.

Several hours later, nearly at dinnertime, he was settled into one of Simon and Rachel Richard's warm chairs, watching their daughter, Dolores, fixing a hot meal. Paul loved watching her silky movements, observing the supple grace with which she moved her long legs, the darting dance of her delicate hands as she drew supplies from the cabinets and deposited them on the preparation surface. He loved the way her hair spun around her head when she turned, the way her tongue licked her lips as she read the instructions on the packages, trying to decide on which to pick. He adored the blue of her eyes, and the way the edges crinkled when she smiled. As a matter of fact, there wasn't a thing about her that he didn't think was absolutely perfect in every way.

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"So, how are your parents?" Dolores asked as she puttered around. "I talked to your mom last week when she came by to send some messages."

His mother had been to Greeley last week? She hadn't mentioned that to him, but then why should she? He'd probably been busy doing one of the innumerable and endless chores his father had set for him and hadn't noticed.

"Are you going to go to Galileo Galilei for the race next month?" she asked as she finally made a decision and tossed one of the packages into the heater. "I hope you like soup."

From your hands I would eat garbage and consider it an honor, Paul thought, but couldn't say that aloud. "Sure," he replied instead.

"I think that Philip is going to enter the race, you know," Dolores continued. "You remember Philip; he's the one I've been dating at school. Tall guy, black hair?"

"Yeah," Paul certainly did remember Philip. He was everything that Paul was not—tall, muscular, mature enough to boast a thin mustache, and, worst of all, the same age as Dolores—seventeen! Paul had hated him ever since he saw Philip holding Dolores' hand in the hallway between classes. He hated the self-satisfied smirk that Philip had on his too-perfect face, and wondered if the clod really and truly appreciated the gift that this lovely girl had bestowed upon him by giving him access to her heart. If Philip ever hurt Dolores, Paul swore, he would kill him. Of course, if Phil happened to die or break up with her before then, Paul wouldn't be too torn up. He'd surely be there to comfort the grieving Dolores, to take her in his arms and hold her close in her moment of sorrow.

"I admire anybody brave enough to enter the race," Dolores went on, unmindful of Paul's wishful fantasy. "Going out there on the ice for two days of continuous racing takes a lot of guts. I just wish I had nerve enough to enter myself." She put the bowl of warm soup in front of Paul.

"Uh, yeah," Paul said, digging his spoon into the steaming container and taking a mouthful, burning his tongue. As he took a drink of cool water he wondered why he always seemed so tongue-tied around her. Why couldn't he talk to her like anyone else? Why couldn't he tell her that she had stolen his heart, his very soul, and that he was hers to command? Why couldn't she see how deeply and purely he loved her?

Dolores was still going on about the race as he prepared to leave. If he left now, he could still make it home before bedtime. Dolores was prattling on and on as if there were nothing more important in the solar system than the damn race that his mother wouldn't let him enter. He sat down in the vestibule to pull on his boots.

"I mean, being out there on the ice, all alone in the dark, racing across Aphrodite, having to keep going and going without resting—it must really be scary, don't you think?" she asked.

"I won't be scared," Paul exclaimed suddenly, the words springing from his mouth of their own accord. "Being in the race won't bother *me*!" he went on, his tongue forming words beyond his control. No sooner than were they out of his mouth that he immediately regretted them. Why had he said that?

Dolores smiled and quickly sat beside him, her hip touching his, her hand on his arm. "Really," she said breathlessly. "You're going to run the race?" There was no mistaking the admiration in her voice.

Paul sat back, momentarily basking in the glow of her smile. "Sure, it's just two days across the Aphrodite plain. Shoot, I've gone on runs for Dad that were longer than that." Well, it wasn't exactly an outright lie—he had gone on longer runs, but there had been places to stop, rest, and get fresh packs. Yeah, and his mother had been with him too, but there was no sense bringing *that* up right at the moment.

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"Well, what have we here?" Simon Richards remarked as he stomped into the hab. "Down for a visit, Pee Paul?" Simon had always used Paul's nickname ever since he arrived on Europa.

"Paul brought the weekly reports for us to transmit to Marcus," Dolores told her father. "And guess what—Paul is going to race the Aphrodite next month! Isn't that exciting?"

Simon glanced at Paul and grinned. "He tell you that? Why, Paul, I'm surprised that someone as young as you are would even think about being in the race. Have you told your mother yet? And how about your father—does he know?"

Paul was trapped. On one side was his Dolores, adoring him, noticing him as a person for the first time he could remember. And on the other side was her father, a rude intrusion upon the scene, demanding truth in place of his lies, making him expose his innocent deceit to the girl he loved. His ears grew hot and he knew that he was blushing beet red from being caught in a lie. "Not exactly," he mumbled as he pulled his other boot onto his foot, stamped to the lock, and pulled the pack into place.

"Bye, Dolores," he said plaintively as he lowered his helmet. She didn't reply.

"See you at the finish line, Pee-Paul," her father grinned widely and laughed as Paul cycled through the lock, stepped into his skis and slid away into the twilight. Paul could feel Dolores' disdain boring into his back as he raced away from the hab, could feel her acid disapproval burning into his heart, searing his soul, melting away any chance that she would ever speak to him again without laughing at his childish behavior.

How could he ever get the nerve to face her again? He *knew* that he would *have* to be in that race, with or without his father's approval! Somehow, some way, he was going to prove to Dolores that he hadn't been lying, that he was as brave as she thought him to be, as capable of testing himself against Aphrodite's ice as that boob Philip and his over-muscled companions.

He glanced back once and saw the blue-green flash of the link arc through the night. His father's reports were already flashing their way along the Wholephore network on racing photons to Marcus. Ordinary radio communication was impossible on Europa because of Jupiter's intense magnetic fields and the continuous bombardment of charged particles raining down, unimpeded by the moon's tenuous atmosphere. To overcome this difficulty JBI had installed a link of Wholephore repeater stations across Europa's face. These used modulated blue-green lasers to burn through the haze of water vapor.

Some of the more well-financed JBI groups used fancy spread-spectrum radio units for short range work, but such devices were beyond the means of marginal harvesters like his father.

Which brought him back to the present. What if Simon Richards told his father about his bragging before he had a chance to talk him into giving permission for the race? His father would have a fit, and probably put more restrictions on him than usual.

There was a chime in his helmet, which puzzled him for a moment until he realized that it was the air supply warning. Damn, he'd been in such a rush to leave Greeley that he'd forgotten to check the pack. He reached back to flip over to the reserve. Then the power unit beeped, and the regeneration unit as well. Now he was really in for it! How could he have been so stupid as to forget something so basic? When his father saw that he had to use the reserve unit he'd really be pissed. Paul would probably get another lecture on safety and have to do safety drills for a week! That's what his father would really be mad about—being stupid about safety.

Paul wondered if he could come up with an excuse before he reached the hab, but his racing mind couldn't produce a

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credible story that he thought would fool his father.

The ice sang a sad accompaniment beneath the slow progress of his skis.

As Paul was nearing home, he looked toward the Sarpedon Linea to see if he could spot the harvester string. Aside from a lot more snow snakes than normal erupting from the minor cracks, there wasn't anything out of the ordinary. The five harvester units were creeping along at their normal pace as they chewed up the deposits on the surface and spit out the processed slush. A tiny spark of light moving among the machines told him where his father was working the line. He was probably adjusting the blades and checking the hoppers, as usual.

As Paul slid down the side of a small ridge he detected a change in the song, just like the other night, only this one dropped deeper and deeper to a bass tone. Something was happening, just like the prospectors had said—something *big* was happening!

Then he saw it coming from the distant horizon. It was a huge snow snake, racing along Sarpedon like a rushing freight train. As it came closer, a matter of only a few seconds, he saw that this was no snake, no tiny linear geyser spewing tiny bits of ice and slush into the air. No; this was a dragon of a geyser, a monster that was pitching its coils far into the dark sky, maybe all the way up to the edges of the thin, one hundred-kilometer deep atmosphere.

But there wasn't time to ponder escape velocity as the dragon roared past, obscuring the harvester string in a fierce blizzard of mist and snow. He felt the deep-throated thunder of the monster's passing through his boots. It reverberated in his suit and rattled his teeth. Paul's vision was blurred as the icy mist enveloped him.

Then the monster was gone. Even Europa's nearly constant voice was momentarily stilled by its fury. Paul stood quite still, hoping that he had not turned around in his excitement. He hoped that he was still facing directly toward the hab, even if he couldn't see it through the enveloping mist. He cautiously slid one of his skis forward, testing the new layer of ice, and then followed with the other ski. The ice coated his suit, forcing him to stop and wipe away the thick layer. Slowly, carefully, blindly, Paul strode toward home.

He hadn't gone more than a few hundred meters when Europa's song returned, angry and discordant. Paul scarcely had time to wonder at what this meant before a hammer blow threw him off his feet.

The ice beneath him felt as if it were alive. The surface rippled and twisted. Paul felt as if he were on a floe in some raging, storm-tossed sea. But that was ridiculous, the Cadmus ice shield was fifty kilometers thick. The raging ocean, if that was what was causing this, was too far beneath the surface to affect him! Something else must be causing this heaving and thrusting! Paul stayed perfectly still and prayed that whatever happened would spare him.

Finally the trembling stopped. Paul found himself lying on the side of a sheet of ice that sloped upwards at a thirty-degree angle. He struggled to get the skis under him so he could stand. He put them crosswise to the slope so that he wouldn't slip back down while he got his bearings.

Which way was the hab? The upheaval had disoriented him completely and the haze of falling ice crystals prevented him from gaining any visual clue as to direction. He couldn't even make out Jupiter through the thick mist. He topped the ridge and slid down the other side where he encountered another ridge. Whatever had happened had turned the flat plain he'd been traversing into a pressure ridge. What had happened to the flat ice plain?

Paul considered. If the Sarpedon crack had been forced open then any

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pressure ridges would have formed parallel to it. All he had to do was follow the flexus between the ridges to maintain his original direction, parallel to the fault, or so he imagined.

After what seemed like an hour of cautious movement, but which turned out to be a mere fifteen minutes when he checked his timer, the mist began to clear. Paul climbed to the top of another ridge to see if he could get some idea of his location.

So changed was the area before him that Paul could make no sense of what he saw. Floes projected up everywhere in a random fashion, punctuating the area with their sharp forms. The only sense of order he could discern was the evenly spaced pressure ridges that rippled away from where he stood. The mist seemed to be thicker on his left, toward Sarpedon itself.

Then he spotted something two ridges over—something large and metallic. Could it be the hab? Paul decided to find out and headed in that direction. A few moments later he saw one of the hab's treads rearing toward the sky instead of being planted on the snow as it should have been. The entire hab was tilted at an odd angle into the sky. He pushed ahead, concerns about his father and mother driving everything else from his mind.

One side of the hab was half buried under several large ice sheets that had overlapped it. There were no lights, meaning that the power was probably out. Paul kicked off his skis, climbed up to the hatch, and wrenched it open. He climbed down into the lock and used the mechanical controls to cycle himself inside. He was glad to feel the pressure equalize. The hab had maintained its atmospheric integrity, which was a good sign. He found one of the emergency lamps right where his father had left it and flicked it on.

At first Paul couldn't make sense of the scene before him when he removed his helmet. Everything loose was all jumbled together. The walls made odd angles to the floor so that he couldn't quite figure out where . . .

Then he saw his mother on the floor, her leg bent under her at an awkward angle. "Mom!" he shouted and kneeled at her side to feel for a pulse. She was still breathing and her heartbeat seemed strong. There was a cut over her temple, and blood spotted the shoulder of her coverall. When he turned her head he noticed the trickle of blood coming from her ear and nose and wondered if she had suffered some sort of concussion. He pulled back an eyelid and saw the dilation of her pupil. He thought hard about what that could mean. Was it concussion? Or worse?

Paul snapped the med kit from its fastenings and tried to treat his mother's obvious injuries. He gently felt her bent leg, fighting his embarrassment at being so familiar with her, but forcing himself to follow the medical protocols his father had drilled into him. He thought he felt a break, just below the knee. Maybe there was damage to her knee as well, but he couldn't tell that with just a hand exam. As gently as possible, he straightened her leg, wrapped a splint, and inflated it. Sofia moaned softly as he did so, but did not wake.

The air started to get close and Paul wondered if the hab's recycler had stopped. Sure, if the emergency power hadn't come on then the recycler would have stopped as well. Damn, what else could go wrong?

Moving as quickly as he could in the mess of the tumbled habitat, Paul found the spare backpacks, disconnected his spent unit, and attached a fresh one. He made certain that the pack's air, converter, and batteries were all fully charged before doing anything else, just as he'd had to do in the drills.

Then he realized something. While the hab was maintaining its atmospheric integrity, there was no guarantee that it would continue to do so. He had to prepare for the worst.

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He pulled his mother's suit from the storage compartment and slipped it over her form as gently as possible. Getting the splinted leg into the suit was the most difficult part of the job, but he managed.

Sofia had something clenched tightly in her hand. No matter how hard Paul tugged he could not pry her fingers loose. Since there was no need for her to use the gloves anyway he just stuffed her arm into the suit, clenched fist and all. When that was done he attached a back pack and made sure that the air flow was set properly. Satisfied that he could do no more for his mother for the moment, he went outside to look for his father.

At first he didn't know which way to go, the landscape had been so ripped asunder. Then he saw Jupiter's rosy rim through the diminishing murk and determined the direction where the harvesters must be. He raced up and down the ridges, pushing on the skis as much as he could, ever wary of suddenly finding himself floating from too hard a push.

Suddenly he stopped dead in his tracks. The jumble of ice fragments and floes stopped a few meters on the other side of the ridge he'd just ascended.

The previous day there had been the Sarpedon fissure, a rough, nearly straight white cleft in the ice running from horizon to horizon. On either side had been the brown and tan deposits, the detritus of earlier geysers that his father harvested. The white and dark bands of ice had gently undulated away from Sarpedon as if they were shallow, frozen waves on the icy plain.

But now there was no Sarpedon Linea, no clean cleft bounded by the lines of brown ice. There was only a smooth icy surface, a frozen river that stretched as far as Paul could see in either direction. Near the center, where he estimated that Sarpedon had been, was a bubbling cauldron of warm, erupting slush spewing up and spreading out, losing heat to evaporation and conduction with the ice beneath as it froze into an even, solid sheet, beneath which lay the harvesters.

And his father.

Paul stared dumbly at the spot where he should have seen the harvester string. There was nothing there save a widening sheet of slick ice. He continued to stare for long moments, wishing and hoping, as if sheer desire could animate the scene and bring the line of metal harvesters back into sight. Paul blinked, hoping to see his father's form climbing among the metal machines but, when his eyes opened, there was no trace of them. No matter how hard he stared at the growing river of ice could he detect even the slightest trace of evidence, the merest hint, that his father had somehow, miraculously survived the cataclysm.

Paul expected that such a shock, such a sudden loss of his father, the solid, uncompromising constant of his life, would leave such a void that he would fall into a pit of sorrow. Instead he felt nothing, an absence of any emotion whatsoever. How could he feel no sadness at this sudden loss, he wondered? Shouldn't he be crying? Shouldn't he feel an aching sense of loss? Had his father's presence meant so little that he couldn't even feel a tug of remorse that his father's body now laid buried deep beneath the ice?

Paul headed back to the hab, disgusted with his lack of emotion, disappointed that he couldn't even shed a tear for the man who guided and controlled his life for so long. He was more upset by the helplessness of his mother, at her injuries, than he was by the death of his other parent.

With that his thoughts turned to his mother's condition. He had to get her to the Richards' place. Surely they wouldn't refuse to help him, to help her, in the face of such a disaster. Yes, his first priority should be to get help for his mother.

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He hurried across the ice to her. She was depending on him now. He was going to have to take care of her.

Getting his mother out of the hab presented problems Paul hadn't anticipated. The floor had tilted a bit more since he left and was now at a precipitous twenty degree slant—not difficult to negotiate if one were careful, but damned hard when encumbered by a surface suit. Paul struggled, climbing up the slope to the hatch. Dragging another person who was also clad in her surface suit was hard work. Her limp body was just dead weight. Paul had to handle her very carefully. He was afraid that he'd do further damage to her broken leg and aggravate her internal injuries, particularly that concussion. As he strained to lift her over the edge of the hatch he wished again that he had more muscle.

The tiny hatch compartment presented a problem. The space between the inner and outer hatches was very constrained, with barely enough room for a fully suited person, let alone two of them. That it was on a steep angle did not help a bit.

Paul solved the problem by embracing his mother with both arms, pulling her close, and backing up and into the compartment. He was nearly lying on his back by the time he got the inner door closed.

Paul awkwardly cycled the hatch with his free hand. His mother and he were face to face, his helmet touching hers. Her slender form limp against him, so limp and submissive. How many times had his father held her so, Paul wondered, and was suddenly aware of their intimacy and the weight of her body pressing against his own. Much to his surprise he felt himself getting an erection. Shame washed over him as he struggled to suppress it, but to no avail. Finally, the air pressure dropped and their suits inflated to push them apart. The outer hatch finally came free and with it escape from his embarrassment.

Once outside Paul secured her on their utility sled. He braced her into a sitting position as best he could. The sled was made to be pulled by their little scooter, which his father usually kept at the side of the hab that was now buried in the ice. He found the short-range communication laser they used to talk to the harvesters where it had fallen from the rooftop mounting. It appeared to be intact when he pulled it from the ice and examined the case. He hooked it up to his power pack and was gratified to see the ready light glow green.

He struggled to climb to the top of the hab, which had visibly tilted even further. The ice beneath it must be collapsing, he concluded, and hoped that he had time to ping the prospectors' hab. He oriented himself and pressed the unit's switch as he watched the receive light. There was no response. He held the switch closed and swept the laser back and forth, sweeping the general area where the transceiver might be in hopes of raising a response.

But there was no reply, which could mean that *their* unit had been damaged by whatever had happened. Worse still, he worried, perhaps their place had suffered just as much damage as his own.

Paul leaped from the top of the hab as it listed suddenly. No sooner than his feet touched the ice than he grabbed the lines he had rigged to the sled and set out toward the prospectors' rig. He didn't look back once at the sinking habitat.

Nor to his father's ice-filled grave.

Paul quickly learned that the sled prevented him from going in a straight line, over the tilted, broken floes. Not only because it exerted too much drag, but because he was afraid of what the jostling might do to aggravate his mother's injuries. Instead he diverted around, dodging the blocks of ice as if he were wending his way through some dim, frozen maze. Occasionally he had to climb a floe to get his bearings from Jupiter's familiar face.

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At one point he encountered an open chasm where a small linea had separated. It might be just narrow enough for him to leap across safely, but it was certainly too wide to do so while pulling the sled behind him. Apparently whatever had cracked the depths of Sarpedon to release its deep waters had also spread the minor lineae that radiated from the central rent. Paul decided to take the prudent step of finding a route around the gap, which required him to travel an hour at right angles to the direction he was heading before he found a place narrow enough to cross without endangering his mother. Then he had to trace his way back, which took as long.

Suddenly, the ice before him was pierced with sharp black daggers of all lengths, forming a forest of dark forms. The exposed portions of the daggers ranged in length from tiny pieces the length of his arm to monsters taller than him. In the middle of this strange new forest was a shattered wreck, all that was left of the prospectors' hab. A truncated portion of the drill rig still stood and, from its center, a tall, impossibly thin line extended far into the sky before it looped over and abruptly ended.

It took a moment before Paul realized that the tremendous energy released from the Sarpedon fault must have forced the drill tube out of the hole, driving it right from its icy sheath and shattering its segments, which then rained destruction as they fell. If the prospectors had been in the hab when the deadly rain of black fragments began, they wouldn't have stood a chance of survival. With a sinking heart he fought his way through the fragments toward the shell of the hab, preparing himself for the worst.

One look into the roofless hab was enough to tell him what he needed to know. Judging from their unprotected forms, both prospectors had been caught trying to reach their suits. Paul was horrified and fascinated at their bodies. Both must have been flash frozen at the moment of death and then decorated by the deposits of falling ice. They would have been glittering ice sculptures of unearthly beauty had it not been for their agonized postures. Their frozen forms reminded him of those ash-formed plaster casts made at the ruins of Pompeii that he had seen in school.

But there was nothing he could do for either Jack or Rob except recite a brief prayer over their frozen forms before continuing his trek toward Greeley station. He added a prayer that Dolores' family had survived, for neither his own nor his mother's pack were sufficient for the long trip to Marcus Station. If Greeley hadn't survived they would both die cold and alone, like his father and the prospectors.

What was he going to do now that his father was gone, Paul wondered? There was no way that he could support his mother on his allowance. There was no way that he could pay back the debt the family owed to JBI for the harvesters and the hab. He knew that his brother wouldn't be able to help; the money that Vince got as an apprentice down on Jupiter barely paid for his keep, let alone having anything to spare.

Maybe, Paul hoped, Vince could come back and take care of Mom so he could go back to school. Then reality dawned—there would be no more allowances, no more school without the harvesters. He would probably have to take some menial, low-paying job at Marcus, something suitable for a kid with no education, to support the two of them. In all probability he'd be stuck on this stupid moon for the rest of his life, unable to buy passage home!

Damn, he cursed as the tears filled his eyes, why did his father have to die? Why did this have to happen? It was going to screw up his entire life! He was so angry that he wished that he could scream at his father for his stupidity at being on the harvesters when the dragon struck. He should have been at

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home, with Mom. Damn him, damn him to hell and back!

The grains of ice beneath his feet seemed to chant an angry curse at circumstances as Paul slid along toward his uncertain future.

The alarm for the primary air supply pinged just as he spotted Greeley. It was a welcome sight. Best of all, the lights that marked it glowed like a bright beacon on the dim landscape. The Richards' hab had escaped the damage! Everything was going to be all right, he practically sang with joy as he skied toward the glow. Simon and Rachel would take care of his mother. They would call Marcus and have a medic come to care for his mother. With a buoyant heart he hurried across the singing ice.

As Paul drew closer to the hab he started to notice signs of damage. For one thing, the hab was at an odd angle, but not from subsiding into the surface. Instead, it looked as if the entire block of ice on which the hab was anchored had shifted to a fifteen-degree angle to the plain. The slim towers that held the navigation markers for the harvester strings were snapped off at their bases. What was worse, the laser array the Richards used to contact Lugh crater seemed to be intact, but they were canted so steeply toward the sky that they were practically useless. Paul wondered why Simon hadn't fixed it as he tugged to open their hatch. Wouldn't communications be their most important priority?

Dolores and her mom welcomed him as if he were some sort of savior come to their rescue, all smiles and joyful cries as he stepped inside. Their happiness fled as soon as Paul informed them that Abraham would not be following. Their faces fell when he told them that his father was most certainly buried beyond recovery in a frozen river that was light-minutes from the warm deserts of his birthplace.

After the Richards got his mother out of her suit and comfortable, Paul noticed Dolores' father, Simon, lying nearby. He was quite pale and obviously unconscious. There was a splint on his arm and a large bandage around his chest. His breathing came ragged and fluttery, as if he had a bad cold. Rachel Richards' eyes darted to him whenever he groaned, momentarily distracted from tending Sofia.

"Dad was on the tower when the shock hit us," Dolores explained as she helped Paul remove his suit. "He fell," she said simply, biting her lip. Then she continued; "The quake shut off our primary generator, so we're running on emergency power. That gives us about a week, unless you know how to fix the generator," she added hopefully.

Paul tried to think of what the loss of the Patterson generator might mean. All of Greeley's power came from the forced cycle of water over the palladium pellets at its core. He doubted that the cell's core had cracked. Even so, there was no way he could fix it. It was more likely that the feed line to the heater buried beneath the hab had snapped when the ice shifted. They were lucky that the shaft hadn't rocketed up through the ice like Jack and Rob's had done. He shuddered when he thought of what that might have done to the beautiful, lovely Dolores.

"I don't think I'll be able to fix the generator," Paul explained as he slid his legs from the bottom half of the suit. "I'm not as technical as my father . . . was." He paused for a minute, afraid that he might suddenly burst into tears. But the momentary pang of sadness he'd felt quickly disappeared. "But a week's more than enough time for Marcus to send someone out for us."

Dolores made a face. "I'm afraid not. We don't know if what happened was local or wide-spread. Even if it was just here there is no way that Marcus would know *we're* in trouble. We only used the link when we had something to transmit. We could sit here for days, weeks

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maybe, before someone at Lugh wondered why we hadn't called in."

Paul thought furiously; with the tower leaning as it was, the Wholephore link was useless. But there had to be some way to send a message. There had to be some way to let Marcus know that they needed help!

He started to pull his suit back on. "I'm going to try to realign the laser," he announced as he tugged the bulky suit over his hips. "Where does your father keep his tools?"

The climb up the tall, leaning tower was long and hard, particularly due to the precipitous angle. At the four-hundred-meter mark he was nearly twenty meters away from plumb, and it would be much worse at the top, far overhead. Paul lashed himself in place to a strut once he reached the level where the laser was mounted. He pulled out a long-handled wrench and began to loosen the fittings on the mount. The barrel of the laser, which had been pointing skyward dipped slightly, warning him that the bolt was nearly too loose. Paul steadied it with one hand while he carefully loosened the remaining bolt with the other. This was no trivial lightweight unit like the one he used back at the hab. This was an industrial sized unit that massed as much as he did.

According to the directions Dolores had given, he had no trouble lining up the barrel to Jupiter's disk just above the horizon. From this spot on Europa, the rings on Jupiter's face were nearly perpendicular to the horizon. Dolores had told him that the closest repeater was even with the right edge of Jupiter's disk. Because of the angle the beam's path looked as if it would barely clear one of the cross-braces.

"Fire it up!" he told Dolores over the intercom they had rigged. Although he was prepared for it, he was still startled when the blue green pencil-thin beam arced toward the horizon. It missed the edge of the brace by not more than a few millimeters.

"No ping," Dolores said over his suit intercom. "Try moving it a little from side to side." After Paul did so, by using the handle of the wrench as a lever, she suggested, "Try moving it up a hair and then going from side to side."

"It's no use," Paul finally admitted when nothing they did seemed to work. "The repeater tower must be down as well. Can we aim this at the next one?"

Dolores sounded puzzled. "I don't think that would work. Even if the next repeater farther down the link is still working we can't see it. It's below the horizon from here."

"Well," Paul answered after thinking for a minute, "If that repeater *is* working, then somebody could go there and use its transmitter to let Marcus know that we need help."

There was short silence as Dolores considered his suggestion. "That's a good idea, Paul, but my Dad's not in any condition to do that, so who do you suggest—Mom or me?"

Paul considered the options as he climbed back down to reenter the hab. Mrs. Richards couldn't go because either she or Dolores had to stay to take care of Simon and his own mother. What's more, neither Rachel nor Dolores had the experience with the ice that he had accumulated over his years on Europa. And his mother certainly couldn't do it, not with a broken leg she couldn't. He smiled as he reached the only logical conclusion.

"I'll do it," he announced as Dolores helped him pull the top part of his suit off. Dolores's mouth formed a small "O" of surprise, but she said nothing.

Paul settled down on a bench and let her help him with the boots. "I'll go down the line to the first working repeater and use it to ping Marcus. If I can use your scooter it should only take a few hours to get there."

Dolores rested her hand on his arm and squeezed gently as she smiled.

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"That's very brave of you, Paul. But think about it for a little bit before you decide. I'll fix you something warm while you think it. I think it's too dangerous."

As Dolores turned away Paul swore that he would never wash that arm again, no matter what. He wondered how long he would feel the warmth where her hand had momentarily rested. Only when she glanced over her shoulder and smiled at him did he start thinking about what he would need for the brief trip. There was no turning back now—he'd look like a coward if he didn't go.

The first Wholephore repeater should be almost two hundred kilometers away. That would be at the limits of a single power pack if he were skiing, but well within range if he used a scooter. He pulled down a fully charged pack, strapped on a reserve unit, and dragged the heavy pack to the hatch. He was about to turn away when he recalled his father's frequent cautions against taking unnecessary chances. Yes, better to be safe, he thought and decided to take *two* packs and one emergency unit with him. That way he could make it back after he sent the signal, even if he had to ski the whole way.

He drank the soup Dolores had prepared as quickly as he could, not even pausing to chew the solid bits that floated in the broth. He washed the soup's taste away with a few quick swallows of water and a piece of bread.

When he finished, he noticed the two women hovering around his mother. When he came close, he heard his mother mumbling something over and over. "My fault, my fault, my fault," she kept saying, broken only occasionally by a sob so heart-rending that Paul wondered if, despite her unconscious state, she knew that Abraham, her husband—his father—was dead.

"She had this in her hand," Rachel said as she handed Paul a small square of worn cloth. It was no bigger than the palm of his hand.

"It's my father's," he said softly and took it from her. He brushed the soft silk threads with the fingers of his other hand. "This is the last bit of a rug my father said that he'd brought from Earth," he explained. His father always kept a tiny piece of it with him in the knee of his suit. That way he could pray in the tradition of his family. Whenever the old one would wear out, Paul's mother would take another small bit of the rug and sew it into the suit. Perhaps she was doing so when the hab was struck.

Paul realized that he was holding a piece of his own family history in his hand, perhaps the last physical trace of his father that he would ever touch.

And still the tears, the sadness would not come. The emotional void remained in his heart. He carefully handed the little fragment back to Rachel. "Keep this for when she wakes. It will mean a lot to her."

He certainly didn't deserve to keep it.

"I am not sure that you should go," Dolores' mother announced when she heard of his plans. "The ice is dangerous, and for one so young even more so! No, I think that all of us should wait here until they can get to us."

Paul was furious. "You can't just sit here in the hope that someone will come for us. You know that they won't realize anything is wrong until they haven't heard from you for a few days."

"Mother's right. Maybe someone from the other habitats . . ." Dolores began.

Paul didn't wait for her to finish. "For all we know, the other habs might be in worse shape than we are, so we can't depend on them for help. We have no way of knowing how extensive the destruction has been! No, we cannot depend upon anyone coming to help us except Marcus."

"But what if Marcus station was destroyed as well?" Rachel wailed. "What if there is no help?"

Paul smiled. "Marcus station was built in the Lugh crater, right on top of the

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biggest undersea mountain on Europa. It's the most stable place on the whole moon, the only place there's any sort of solid ground.

"Besides," he added quietly and with resignation, "If Marcus is destroyed then we are all dead anyway." With that sobering thought he began to don his suit for the long trip. Dolores helped him as her mother sat between Simon and Sofia and cried uncontrollably.

"She'll be all right," Dolores whispered bravely. "It's just that *this* is such a shock to her." The sweep of her hand took in the damaged hab, the emergency lighting, and the unconscious forms of her father and his mother.

"I understand," Paul said sympathetically. He wondered what her reaction would be if he took her into his comforting arms, but was afraid to try. "Take care of all of them until I get back," he added as bravely as he could. Somehow their roles had become reversed; the children had become responsible for their parents.

"I will," Dolores promised and then, impulsively, leaned forward, just as Paul was lifting his helmet into place, and kissed him quickly on the cheek. "Good luck and . . ." she said quickly as she stepped back. The helmet clicked into place and cut off her words.

Paul was so shocked by Dolores's sudden display of affection that he nearly forgot to double-check the status of his pack as the hatch cycled. Was it Europa's faint gravity that made his steps so light or his sudden feeling of euphoria? What did it matter—Dolores obviously thought of him as a hero, someone who would rescue her from the destruction wrought by the ice dragon.

The ice sang a gay song as he attached the utility sled to the scooter and strapped the packs in place. He could hardly wait to discover what Dolores' welcome might be when he returned.

The surface seemed to grow smoother as he followed the blue-green strobe that flashed overhead toward Jupiter's red grin. He'd asked Dolores to strobe the laser every hour on the hour to provide a guide that would keep him on track. He drove cautiously along for there was no telling if the dragon would awaken once again and turn the ice beneath the scooter's treads to fluid. Caution was his watchword.

The monotonous landscape of pressure ridges soon lulled Paul into a dreamy state. Up one slope he would go, tip over the crest, and speed down the reverse side. Then he would cross the valleys between and repeat, again and again. It felt as if Europa was breathing, as if the moon's breast was heaving and falling in time to the ice dragons' slow movements beneath. He recalled how wondrous Europa had once seemed to him—the barren ice plains, the cold stars above during the three-day-long sun cycles, and the ever-present brooding giant of Jupiter forever peering over the horizon between.

When they'd started this year's harvester string over two hundred kilometers further away from the meridian, Jupiter had been hardly more than a slim frown at the horizon. Now, he was so close that nearly one-third of Jupiter's face could be seen.

Paul increased the scooter's speed, ashamed for being so slow and cautious while Simon and Sofia were desperate for medical aid, possibly dying, behind him. Not even when the scooter shot off the top of one sharp crest and floated softly to land mid-way down the slope did Paul slow down.

The suit's timer chimed and Paul glanced up to see the scheduled blue-green strobe. At that moment the scooter hit something and tilted wildly to one side. Paul twisted the handlebars to the right as the machine bucked from side to side, but succeeded only in rolling the vehicle.

Over and over he tumbled, the thick suit pack thudding hard every time it hit, wrenching his shoulders time and

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again. He was afraid that the scooter would crash into him, smashing his suit, cracking his helmet, or tearing off an arm or leg. All of these possibilities flashed through his mind as he rolled down the slope.

Finally he stopped.

He found the scooter twenty meters away. It was lying on its side. It had hit so hard that its nose was buried in the tilted slope of the next ridge. Paul walked around it, trying to figure out how to right the machine so he could continue. He located the sled a little further along. Apparently it had become detached at the moment of impact and continued over the ridge and up the next, where it perched on the crest. Surprisingly, it was still upright with its load still attached.

He'd struck a sharp shard of hard ice, which had sent the scooter out of control. From where he stood the shard looked like nothing more than a large tooth of some primitive carnivore. Perhaps it looked like a dragon's tooth, Paul thought fancifully, remembering his earlier dreams of Europa's dark beasts.

He discovered that he could tip the scooter by grabbing one handle and leaning backward, using the combined mass of him, his suit, and the backpack to counterbalance the scooter. After several jerking motions he managed to tip the machine far enough that it came free and settled on its treads.

Paul attached the sled before setting out once again. No more daydreaming, he promised himself. He would stay alert. He would use caution. He would keep his eyes on the ice just ahead of the scooter.

Which was why he nearly missed the first repeater tower and had to double back to find it. The line-of-sight Wholephore repeaters were spaced just near enough that the arrays on their tops could be seen above the horizon from the next one in line.

But there was no way that he could use the tower to spot the next in line. The remains of the repeater tower were scattered over nearly a kilometer. One of the tall tower's anchors had torn loose during the cataclysm and, when the surface shifted, had allowed it to fall. The huge laser housing was buried a meter deep in frozen slush with just its leads showing where it had landed. It was far too heavy to lift and, even if he could have moved it, he wouldn't be able to place it high enough to see over the horizon. Neither could he locate the unit's power supply.

Paul considered his options. The two additional packs would easily last until he reached the next tower. He'd still have enough left to make it back to the hab . . . and Dolores. He was glad that he'd thought to bring the extras along with him.

The going was easier the closer he got to the meridian. The ridges were not so sharp, nor so tall. Whatever had caused the dragon to roar seemed to have played out as it travelled along. Perhaps he could get back to some flat ice plains further along and make better time.

Paul began to be concerned when the scooter began to slow down two hours later. There was enough power, according to the instruments. He began to worry that something had been damaged by the crash, something that he hadn't noticed until now. Maybe the slowing was due to nothing more than a connection that had jiggled loose. He decided to check, so he brought the scooter to a halt.

Paul could hear the song as he stepped onto the ice—a muted, bitter tune that seemed to hint at trouble. He'd heard that song once before, but, at the moment couldn't place where that had been. He vaguely recalled something his father had warned him about . . .

Then it struck him; this was the song the slush made as it was in transition. He glanced overhead at the brilliant dot of the sun. Of course, the slight radiation from the distant sun was enough to

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sublimate certain types of grains during the day cycle. He glanced at his boots and saw the ice creeping around the edges. If he stood here long enough he'd sink into the surface. Well, he probably wouldn't be here long enough for that to happen, he thought. He lifted the lid of the scooter's power unit to see which of the leads had come loose.

He wiggled the connectors but all of the leads seemed to be tight. He checked the battery and, when that looked like it was supposed to, checked the power train connections. Surely something had to be loose to cause the scooter to lose power like that. What could it be?

Then it dawned on him. Of course; if it hadn't been for his helmet he would have smacked himself on the forehead. It was the slush itself that had been slowing the scooter—apparently he had been driving all this time right into the middle of a polyna, one of the pockets of warm, unhardened slush that occurred this close to the meridian. *That's* what his father had warned him about, that's why it sounded so familiar.

Ruefully, he closed the lid and started to throw a leg across the scooter when he noticed that it seemed to be sitting a little lower than before. He glanced down and saw that the slush was coming up, over the scooter's foot rests! The heavy mass of the scooter had been sinking while he'd been fooling around with its innards. He leaped into the seat and threw the power onto high.

A plume of slush shot from beneath the scooter. It buried the sled behind it in a glistening coating of ice, but didn't impart any forward motion to the scooter. Paul gunned the scooter again and again, pulsing the drive belts and applying as much torque as he could get out of the motor. All he managed to do was dig the scooter deeper and deeper into the polyna.

When he took a quick look back, Paul saw that the sled was beginning to tip forward into the growing depression. In a panic he slid off, untied the sled, and pulled it to one side, where it would be safer, he thought.

He dashed back and tied a line to the scooter's cowling, backed away, and wrapped the other end around his waist. He pulled with all of his might, but he could not pull the scooter loose from the tightening grip of the slush sink, not with his limited strength. He continued to pull, each tug driving his boots deeper into the slush, but the scooter remained trapped in its hole, its nose tilting skyward.

Paul was pulling his boots free and trying to figure out what to do next when he noticed that a larger depression was growing around the small one the scooter had dug. It looked as if the whole area, the entire polyna was going to subside!

In a moment of sudden terror he untied the line about his waist and threw it free. He scrambled away as fast as he could move, panicked by thoughts of sinking into the ice. He pulled the sled with him and made his way to a nearby floe—an outcropping of hard ice adjacent to the sink. No sooner than he had reached the refuge when the center of the polyna abruptly collapsed, consuming the scooter in its cold maw as the surrounding slush closed in to fill the depression. In a matter of seconds the scooter had vanished. The polyna resumed its placid, non-threatening appearance.

Paul cursed himself. If he had just taken it easy and not panicked maybe he could have pulled the scooter free. What if he had taken it slowly after detaching the sled instead of gunning the power? What if he had locked the drive on *and* simultaneously pulled on the line? Yes, surely that would have worked. A dozen other possibilities that he had not tried came instantly to mind, all seemingly foolproof methods of saving the scooter, all unrealized, all futile speculation. If only he had been smarter, stronger, faster.

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Like his father.

The plain was cold and lonely. Because he had long since passed beneath the horizon of Dolores's hab he could no longer see her hourly strobe signal and had to rely on the face of Jupiter to guide him. He kept heading toward that fifth band from the right, the tan one. The one where, Dolores had promised, the tower was located.

He had been walking for hours, sliding his skis slowly over the ice and listening to Europa's angry song about his stupidity. If there were ice dragons beneath the ice they were probably laughing themselves silly over his actions. *Imagine,* he could hear them giggle in their dragonish way, *a mere child trying to best the ice. How ridiculous, how insane. How futile!*

But Paul continued to push onward. He had no choice but to reach the next tower if he was to send his message. He couldn't make it back with the air and power in the remaining packs.

An hour later he arrived at the second repeater. This one was just as useless as the former one. The tower was erect, but the laser housing had shifted so that the Marcus-side barrel was canted at a steep angle toward the ice. Although Paul tried mightily, he could not shift the heavy unit back into position. Even the wrench was an inadequate lever.

He tried pulsing the unit a few times by shorting the power leads, but the beam hit the surface just a few hundred meters away. It made a tiny puff of sublimated ice where it struck.

Paul considered his options. He had enough air and power left in the packs to maybe make it to the next tower, just barely. But that shouldn't be a problem; the rescue squad could pick him up on their way to the Richard's hab. They could even take him with them to save time.

For a moment he relished how Dolores would react when she saw him riding to her rescue; a brave knight who had gone forth to slay the ice dragon. Well, not really slay the dragon, but to beat it, perhaps, he added wistfully. Then she would throw her arms around him and kiss him long and deep, pressing her body against his as if promising greater delights to come.

Yes, he decided, he would certainly ski to the next tower. After all, it was only another hundred and fifty klicks or so. So he, Dolores's brave hero, would go on for her, for his mother, and the others! He would save them all!

The snow snakes grew less frequent as he plowed along, denying him their fickle company. All he had besides the constant movement of one ski before the other was Europa's constant song. He started to imagine that a huge green dragon was following him, hissing about all of the stupid things he'd done. That was as it should be. If his father had been around, he would have cursed Paul for being so dumb and unmindful of his own safety.

And Paul would have stood silently by, listening to the sad iteration of his mistakes—his stupid errors—and be shamed to tears, wilting under his father's harsh criticism.

Why had he panicked when the scooter was trapped? He knew that panic was just proof of his lack of courage. Behind the brave exterior he had displayed to Dolores and her mother was the reality of his hollow, shivering, shaking, *cowardly* self.

You are a pitiful creature undeserving of your mother's love and affection, let alone someone as wonderful as Dolores, the green dragon whispered in his ear.

Then a blue dragon joined the first. *The true story of your bumbling will eventually come out,* the blue dragon promised him. *You'll never be able to tell a consistent lie,* it said.

Yes, Paul agreed, and Dolores and the others would all laugh at him, ridicule him for thinking that he could win

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against the ice. How did he expect Dolores to ever believe that he would race the Aphrodite if he couldn't even drive a stupid scooter a few hundred klicks and make a simple signal, the green dragon asked?

Paul's fantasies of Dolores' admiration faded away like the sublimating mist before the green dragon's harsh revelations.

The ice dragons' songs were a critical chorus, repeating over and over as he plodded along.

Paul felt that he had to rest. It had been nearly twenty hours, he realized, since he'd slept. It seemed an eternity ago. His legs were burning up and sweat was pouring down his back. In a way that was funny. Here he was standing on the surface of a moon whose average temperature was nearly 140 degrees below zero, surrounded by hectares of ice and standing on a frozen crust a hundred kilometers thick and he was working up a sweat! He settled onto the sled, wedging his behind into the space between extra packs.

He felt hungry. After all, that bowl of Dolores's soup had been the last food he ate. He sucked on some ProGoo—Protein Paste, Type IV, Edible—the JBI label read. The stuff tasted like gritty dough, and tasteless dough at that. But he was hungry, so he gulped some more, not stopping until the tube was empty. He washed the last mouthful down with a swallow of tepid water from his recycling unit. It tasted faintly of ammonia, as usual.

The ice for the last few kilometers had been singing a different song. The surface appeared less grainy and he'd encountered stretches of solid ice. On those occasions he'd been able to slide nearly effortlessly, with just slight pressure on his skis. But those stretches had been rare. Most of the past kilometers had required the tiring push and slide.

Jupiter appeared to be slightly higher now, or was that just wish fulfillment on his part, he wondered. As he lazily watched, the ruddy planet seemed to wink at him and then slide to one side, tipping over and drowning in a darkening sky.

The blue dragon erupted from the snow with a mighty heave of its coils. The green one followed close behind, moving in concert with the blue's. Paul understood that their cries were of responsibility and duty, of his failures and his shame, even if he couldn't make out their exact words. He winced beneath the dragon's assault. He put his arms above his head, trying to protect himself as their sharp words rained down.

But the dragons would not let up, would not give any quarter, so fierce was their attack. Paul felt like crying. There was nothing he could do, nothing to stop their words.

He glimpsed a rose-colored dragon moving behind the other two. Its graceful form hinted of promise, of fulfilled dreams and desires. Paul knew in the depths of his heart that the rose would give him peace, that it was love made real. He reached out a hand to beckon it to him and . . .

Paul snapped awake. The ice was empty. The stars and brooding Jupiter dominated the sky. There were no dragons.

How long had he slept? He glanced at the time and realized that he'd been sleeping for nearly three hours. That was three precious hours that could have taken him that much closer to rescue. He flogged himself to full wakefulness with a curse. The snow song chided him for his laziness as he trudged along. He could still feel the hot breath of blame from the dragons on the back of his neck.

The air alarm chimed a little later. Paul kept going until the air grew stale in his suit. He wanted to stretch his pack's resources as far as he could, but didn't want to push his luck too far. "Better to lose a little air than your life," his father had always cautioned him on their long trips. It was good advice so Paul detached

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the spent pack and attached his suit to a fresh one. He debated carrying the spent pack with him, but decided against it. The sled was growing increasingly difficult to pull as he tired, and less weight translated into more speed and less energy expended. Without the added weight of the pack maybe he could make up for the time he'd lost while napping. He perched the used pack on a crest of ice, where it could be easily spotted for later retrieval. He skied away as rapidly as he could, the dragon's cries and the song filling his ears.

Four hours later his left calf started to hurt. It started with a tight feeling in the back of his leg, which he dismissed as nothing more than weariness—another sign of his physical inadequacy, or so he thought. Neither Vince nor his father would have allowed the ice to tire them so easily. He tried to ignore the occasional stabs of pain and growing heat in his left leg as he pushed relentlessly forward, heading always toward Jupiter's frowning face.

When the cramp struck he thought that something had struck his leg, hard. He pulled his left leg up to relieve the pressure without thinking and pitched forward. He rolled across the ice in agony as his calf muscle kept tightening and tightening. It felt as if the cramping muscle was going to pull his leg apart. It felt as if the contractions were going to rip muscle from bone at heel and knee. The arch of his foot screamed in pain. He tried to clench his foot to relieve the stress, but it did no good. He reached down to massage his leg but his gloves only struck the unyielding outer skin of his suit, beneath which his leg was surely tearing itself apart.

Paul beat on his leg, hoping somehow that the pressure of his blows would penetrate the suit and help relax the rock-hard muscle. But his blows were futile as the leg continued to throb and pull in agonizing waves of pain. Relax, he told himself and tried to will his muscles into relaxation, tried to order them to cease, to rest, to do anything except continue to pull, pull, pull until he felt as if he would scream.

Then he did—long and loud, protesting against this attack by his own muscles. He cried out, protesting the failure of his body to respond as he wished. But the screaming did no good, neither did the steady stream of orders for his muscles to relax. Nor did his attempts to ignore the pain that seemed to grow to fill his mind.

What were the blue and green saying now? Where was the rose that promised so much? Were the two dragons laughing at his woes, at his pitiful whimpering over a little physical discomfort? Surely they must be joking at his puny efforts, at his attempts to conquer their domain.

How had his father fared in the depths, he wondered, half out of his head with agony. Paul could imagine Abraham battling these dragons as he descended into the ice, fighting them all the way, forcing them back with each breath of his limited air, fighting his cooling suit, denying them his dying body as long as possible. Yes, his father wouldn't have submitted easily—he would have fought to the very end, using every fiber of his body, every bit of his energy to try to escape, to evade the greedy monsters of the deep and deny them their victim. And it had all been for nothing. The dragons had won after all. His father had died.

And still the tears did not come.

A long, agonizing time later, the vise finally released his leg muscles. Paul rested for a few moments as the cramp relaxed. He reveled in the cessation of pain, enjoying once again having control. He wiggled his toes and, with great caution, tested his leg. It hurt to move, but not so much that he couldn't continue. He slid the skis forward and back, wary of putting too much stress on his sore leg and causing it to cramp once

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more. He continued his trek more slowly and cautiously than before.

The snow snakes blew by him several times. The larger ones warned him of dangerous cracks in the ice, the small ones indicated tiny lineae that were no problem. After a while Paul grew so tired that he stopped paying attention to them. He stopped noticing anything except the texture of the ice immediately ahead of his skis and the ever-present tan band on the face of Jupiter.

His hunger had grown to be nearly unbearable over the last few hours. His belly growled continually, echoing within the hollows of his empty stomach. He regretted eating the entire supply of paste. He should have saved some for later, when hunger struck again. The reflection did little to still the growling cries of his stomach.

Paul recalled the last time he had eaten *real* food: It was that bowl of warm soup that Dolores had fixed for him before he left. Yes, he recalled, the soup had potatoes, carrots and peas in it, plus either chicken or turkey or beef. He could remember the thick broth in which the various components floated. It had been a rich brown fluid that was spotted with circles of fat that had merged and separated when he stirred them with his spoon. He tried to recall the smell from the wisps of steam that rose from the soup's surface as he drank, but he could not.

Why had he wolfed the soup down so quickly? He should have taken his time. He should have savored every morsel, every sip of the rich broth. He should have paid attention to every single one of its complex flavors. He should have carefully extracted each slice of potato, each pea and carrot, each floating bit of celery, and tasted them individually, rolling them around in his mouth, indulging his taste buds in their natural flavors and the way they blended indescribably with those of the total mixture. He should have . . .

A sudden snow snake erupted to one side, spewing a geyser of slush higher than Paul's head. Paul tried to dodge away from the falling ice and, in so doing, struck the edge of a crevice. The ice under his skis gave way and he felt himself falling as the horizon whipped around him.

It was over in a matter of seconds. Paul found himself wedged in a crack just below the surface of the ice. He was lying on a thirty- or forty-degree angle to the surface, with his head at the lowest point. His skis were still near the surface. The tip of the right one was still caught on the edge.

Paul checked himself to make certain that he hadn't broken anything, that the fall hadn't harmed the integrity of his suit, that the impact hadn't damaged his survival pack. Everything seemed to be all right.

He felt so stupid. Why had he been daydreaming about that damned soup instead of paying attention to where he was going? There would be plenty of time to eat, to enjoy much finer food than instant soup when he led the rescue party to Dolores and his mother. Daydreaming—it was just another one of those things his father had criticized him for. Why was he always thinking of something else instead of paying attention to what he was doing? Paul could practically hear his father saying those words—and, for a brief second, imagined his large form standing at the edge of the crack, peering down and shaking his head at this latest evidence of Paul's ineptitude. Paul thought that it served him right. He had been daydreaming instead of paying attention.

Well, no sense staying here chastising himself, Paul thought and tried to pull himself up. He tugged again, trying to rotate his shoulders to extend his reach. But it was no use. No matter what he did he could not budge.

It was ridiculous. His head couldn't be more than a meter below the surface, resting in a crack only slightly wider than his shoulders. Why couldn't he move?

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Paul carefully reached up with one gloved hand and took hold of the edge of the fissure and pulled while trying to bend his right leg. He moved a little and then stopped. No matter how much pressure he exerted he could not get loose. It was as if there were something holding him back.

Paul wiggled his hips and moved his left ski. Everything from his waist down seemed to be free, so whatever was holding him in place must be located *higher, somewhere around his shoulders.* He rotated his shoulders, extending one arm and then the other. From what he could feel, it seemed as if it was his back pack that was stuck. All he had to do was release it and climb out.

Right, all he had to do was cut off his air and the power that kept his suit warm. That would be smart, wouldn't it? It would also limit his survival to about five minutes, give or take a few breaths of freezing air. Dropping his pack was as smart as opening his helmet to take a breath of barely present, but fresh, atmosphere of ammonia and methane.

Yet, what choice did he have? He couldn't just lie here and wait for the end. Maybe, just maybe, he could retrieve the pack once he got himself out of the crack and reattach it in time. He put his hand on the pack's release handle and then hesitated. If he tugged the release he could be signing his death warrant. He could be committing suicide out here on the icy plain where no one would find his body. Then he imagined how stupid they would think he'd been if they did find his frozen form. He could hear their words of scorn—*Only a fool would release his pack without having a spare handy!*

Wait a minute! Perhaps the sled with the extra pack hadn't fallen into the crack. Maybe it was up there on the ice, out of his sight. Sure, it was just sitting there, waiting for him to attach it once he was free. In that case releasing the pack would let him reach the emergency pack, that was all.

As the certainty of the sled's existence grew in Paul's mind his hand clenched on the release. Paul took one deep breath, wondering if it was the last bit of fresh air he would ever experience, and pulled. The releasing connectors clicked off, shutting down air, power, and recycler.

Paul grabbed the edge of the crack and pulled, half afraid that he would still be unable to move, fearful that he had not only cut himself off from his only *chance of survival but had failed to consider* something obvious. He pulled hard wit both hands at the same time that he flexed his right leg and swung his left. With great relief he felt himself break free.

Within seconds he was climbing out of the crack and scanning the ice for sight of the sled. But it was nowhere in sight! Paul panicked and threw himself belly first on the ice. He reached down into the crack. He grasped the sides of the wedged pack and tugged hard. When it didn't immediately move, he twisted it this way and that, shifting it back and forth as he desperately tried to get it loose from where it was stuck.

The pack moved slightly, but Paul had difficulty pulling it to the surface. He considered the situation for a minute as the air in his suit began to chill and grow close. He wondered how many minutes of life remained to him. Was the air running out already? Was the cold creeping in on him?

He had to get that pack out! He tried to slide it to the side as he twisted, and then tried the opposite direction. Then he alternated, switching it right and left as he tugged furiously. Finally, the pack came loose and flopped onto the ice beside him as he went over backwards.

Paul, gasping for breath, brushed the shards of ice from the pack's connectors, making certain that there was nothing to interfere with their seating properly. He positioned himself over the pack and leaned backwards. He shifted slightly and arched his body to bring his

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suit parallel to the face of the pack. He wiggled around, praying for the connectors to slip into their receptacles before he died from lack of oxygen. Why wouldn't they click home? What was he doing wrong?

Then he felt the primaries click home, followed quickly by the secondaries. Immediately he felt a welcome rush of fresh air flow into the helmet. He breathed deeply of the pure air. Nothing had ever tasted so sweet.

He pulled himself to his feet and looked into the crack. Farther down, below where he had been wedged, was the sled. There was no way he could reach it, no way he could retrieve it.

He checked the time he had remaining on his pack. It had been eight or nine hours at least since he had activated it. That only gave him another three hours, four at the outside, to find the tower, call Marcus, and be rescued. If he didn't get the tower to send that signal he was going to *die*!

He quickly oriented himself to the giant disk and set off as quickly as he could. His eyes scanned the horizon for some sign of the tower, some evidence that he was nearing his goal. His mother was depending on him, Dolores was depending on him. If he died then they would too—and he would be responsible!

The green and blue dragons continued to curse Paul as seven kinds of a fool. Look at all of your mistakes since setting out, they scoffed. Why had he thought that he could do such a stupid thing? He was just a kid, as his father had told him so many times in the past. He had no business setting out on this insane rescue mission.

Paul wondered; had all this merely been to prove to his father that he could do something brave and difficult—to give his father a reason to be proud of him? But that was a stupid reason, he corrected himself—his father was dead and frozen into the depths of the ice. His critical father was now the companion to the ice dragons. No matter what Paul did there was no way he could ever again impress his father.

There is no way that you will ever hear words of praise from his frozen lips, the dragon promised.

But perhaps it had been Dolores, not his father, that he had been trying to impress. Paul recalled that how he had puffed with pride as he announced that he would bravely set out to save them all. He remembered the admiration that he saw in her eyes. He recalled that brief, sweet touch on his arm, and the quick kiss that followed. *Was it for those things that you set out?* the dragons asked.

Paul wondered if Dolores had encouraged him to do those things while laughing inside at his childish pretensions. Maybe the kiss was only to encourage him. She knew full well that he probably wouldn't succeed but was willing to let him take the chance to save her life and that of her parents.

What a fool you've been, the dragon crowed as Paul plowed onward, slide and step, slide and step, slide and step until the ice, the song, the keening voices of the dragons, and the steady hiss of the recycler and air blended into a single orchestration of self-pity.

All Paul wanted to do was lie down and rest. After he had something to eat, that is. And drink. To conserve air he was trying not to breathe too deeply. To stretch the pack's power supply he'd cut back on the suit's heaters. As a result his feet were so cold that they'd stopped hurting and felt more like blocks of ice. He could no longer feel his toes. He had to look down to see if his boots were still attached to the skis.

He kept sucking on the dry water nipple but, with the recycler on low, water production was slight to none. Occasionally he managed to get a drop or two out of the reservoir, but it was never enough to slake the fierce thirst he'd developed. He could go without water, he

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knew that, and the hunger pangs were nothing to worry about. Right now his body was probably burning the fats and sugars in his cells, cannibalizing his own tissues to fuel his efforts as he pushed himself beyond endurance. He tried to ignore his protesting belly.

The ringing in his ears occasionally managed to drown out Europa's song and the dragons' cries, but he didn't know which was preferable.

His hands were numb from the cold that penetrated the gloves. His fingers felt like swollen sausages—deep-frozen sausages at that. Damn, have to stop thinking about food, Paul cautioned himself. Can't risk losing concentration again. Don't want another accident. *Had* to push on! *Had* to get to the tower! *Had* to send the signal that would save his mother and the others! Had to show her that he was as good as his father!

The snow sang a slow tango in time with Paul's heavy movements.

The emptiness in his stomach was constant, nearly overwhelming. It was matched only by the soreness in every muscle of his body. He no longer noticed the pain in his legs, although always alert for any sign of another imminent cramp. He didn't know what he would do if that happened. He didn't have enough time left to deal with another delay. If he fell he would die, he would simply *die!*

The possibility wasn't that fearful now. Dying, he realized, would provide relief from the hunger, the pain in his arms and legs, and the constant cries of failure from those damned dragons that he still heard whispering in his ears, crying their triumph over his puny efforts to best the ice. He tried to ignore their mocking voices as he pushed forward, driving his legs beyond anything he had ever imagined he could do, driving himself beyond his physical limits.

He started to see the dragons in the murk, or perhaps they were simply snow snakes transformed into fierce and glowering dragon shapes. The green hissed menacingly of his failures to measure up to the standards his family set for him, his physical inadequacies, his lack of foresight, his daydreaming, his false pride. For some reason the blue dragon said little. It remained aloof and cold, intimidating him with its huge, overwhelming presence.

The smaller rose dragon still lurked behind the others. It was a quiet one, scarcely making a sound as it coiled itself over and around, twisting sinuously on the ice, presenting itself in ways at once inviting and menacing. Paul tried to get a clear view of the rose dragon as it faded into and out of sight behind the others. Why, he wondered, wouldn't the blue and the green move out of the way so that the rose could reach him? He tried to focus on it, tried to mentally force the dragons aside so he could understand what the rose promised. He thought that she resembled Dolores in the face, a lovely dragon indeed. Yes, definitely a *she* dragon!

Paul halted suddenly, teetering to a stop on the edge of a high cliff. It was almost a hundred meters to the plain below. It took a moment for the meaning of the cliff to sink into his weary mind. Somewhere along this ridge must be the tower he was supposed to reach. Paul tried to figure out where the tower might be if not here. He was pretty sure that he'd maintained the right heading, had kept his track as close to a straight line as possible to the tan line. But, if he had done that then where was it? He scanned the ridge from horizon to horizon, searching for some sign of the tower.

It was nowhere to be seen.

He looked across the plain toward Jupiter's giant face. From this close to the meridian he could see nearly 70 percent of the planet's face. He tilted his head to better observe the ruddy planet's glowing orange and brown disk, a friendly globe of apparent warmth among the icy diamonds of its companion stars. He could clearly see the curve

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of Europa's too near horizon, nearly twenty kilometers away at this height, against the bright rose disk

On the plain down below, halfway to the horizon, was a glint of light, a bright speck in the rosy murk. That, he knew, would be Marcus station, humanity's main habitation. Down there were hundreds of souls, people who could help him, if only he could reach them. If he squinted, he could just barely detect the outline of the Lugh crater in which Marcus station rested. He estimated that the station was merely fifty or sixty kilometers away from the bottom of the cliff. He would have thought that quite close, under normal circumstances, that is.

But before he could traverse that short distance he had to climb down the icy cliff before him. He prayed that he had enough time left on the pack. He was afraid to check his telltales for the grim truth they might reveal.

Nearby he found a rough shelf that ran downward on a slight, twenty-degree slope. It was wide enough for him to walk sideways, but he had to remove his skis to do so. There was no way he could climb down the cliff with them attached. He felt the dragons' critical eyes upon him as he stepped onto the ledge and started down.

The ledge narrowed to hardly more than a boot's-width when he was just a hundred meters down the cliff. To continue onward he had to turn to face the cliff. That way his pack wouldn't force him outward over the emptiness. He moved carefully sideways, solidly planting each frozen foot before putting his weight on it. He flexed his body to throw his weight inward, toward the cliff. He moved step after tiny step as his gloves constantly searched for handholds to stabilize and balance him. It was difficult to feel the holds with his frozen fingers, but he managed.

Then his left foot came down on emptiness. The shelf had run out and he was barely one-third of the way down the cliff. Paul strained his neck as much as he could to look along the cliff. He could hear the dragons hissing their poorly concealed humor at his predicament.

Just to his left there were some projections that looked as if they might support his weight, but to reach them he had to reach out further than the tiny steps he had been taking. Once his foot rested on the nearest projection there would be no way that he could recover. There would be no way for him to return.

You've been a fool, the green dragon hissed. *Taking foolish chances without checking first. You don't deserve to survive!*

Go forward, the blue dragon ordered and offered a coil for Paul to step upon. *Come dance with me*, the blue invited him. *You will die anyway, so you might as well die trying, just like I did.*

Paul snapped awake! Was that what the dragons were, phantasms of his father, his critical, unbending, demanding father? But the green wasn't like his father, not at all. His father had been a hard-working, loving man who cared deeply about Paul—that was what all the criticism had been, a way of molding Paul into someone who could defeat the ice. His father's advice had helped him come this far. The blue was right—better to die trying, better to fight to the end!

As best he could tell, it looked as if there were a wide ledge just beyond the footstep. To reach it he would have to step and then, using his momentum, step again to gain the ledge. He would have to dance with the dragon. It would only take one misstep, one missed grip of either hand to send him crashing to his death.

Paul held back for a few minutes to gather his remaining strength. If he moved his right hand over to grip the hold under his left hand, moved his right foot closer, and then moved his left hand to that first bit of projection, then he just *might* be able to cross the gap to the ledge on the far side.

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Paul could feel his heart racing, taste the acid bitterness of his empty stomach in his mouth, and feel the contractions in his scrotum. He had never been so afraid in all of his life, never faced the certainty of his own death so directly.

Dance with me, said the blue dragon. *What have you got to lose?*

Yes, what *were* his choices: to return to the top of the cliff and die while watching Jupiter or to hang here until his pack expired and he blacked out? No, he had to make the attempt to reach the shelf. He *had* to dance with the dragon!

He moved his feet into position, braced himself, switched the handholds and lunged. The instant his left foot extended over the precipitous gap, his left hand reached out and he pushed with his right foot as hard as he could.

His left boot struck the projection and he pushed on it, not taking time to even wonder if it would hold, and swung his body over the pivot point. Both hands scrabbled for a hold on the frozen face of the cliff as his momentum continued to carry him across.

Then his left hand contacted something. He pulled desperately just as the projection under his left foot collapsed. For one stomach-wrenching microsecond he was supported only by that single grip, that single point of contact with Europa. His shoulder felt as if it had been pulled from its socket from the strain. He felt his fingers slipping, opening despite anything he could do. He screamed and felt his bowels spasm with raw fear.

His feet struck first, a solid thump as the left and then the right boot struck the ledge. For a moment he teetered on the edge, the pack threatening to overbalance him and tip him backwards into the void. Paul dropped to his knees, his fingers dug into the ice in desperation even as his brain was trying to catch up to events.

Paul pressed his helmet against the surface of the ledge, breathing raggedly as he hugged the ice. He had made it! He had survived the gap. He had danced with his dragon and survived!

He wiggled around so he could sit up and regain his composure. He had to rest for a few moments before he could continue. He stared back at the gap he'd crossed, unbelieving of his good fortune. Had the ledge been on the same level, as he'd thought, there would have been no way he could have reached it.

He gazed across the plain. Marcus was just as close as before. At the same time, Marcus was just as far away. He still had to get down the rest of the damn cliff. He looked to the right to plan his next few moves.

The ledge where he sat continued for another few meters and then disappeared around a corner. Paul struggled to his feet and carefully maneuvered himself to the corner. He peered around to see what his next steps must be.

The corner was the edge of a large crack that ran from the top of the cliff to somewhere far below. The depths of the crack were so dark that he could not tell if the shelf continued further back or not. Certainly it looked as if the crack was getting narrower toward the back, near where it disappeared into the dark. Paul worked his way around the corner, turning once again to face the cliff so that his pack wouldn't get in the way. He proceeded cautiously, feeling blindly with his foot as he moved forward.

Paul was already throwing his weight forward when he stepped onto empty space where he'd expected solid footing. The shelf had stopped abruptly. He reached out desperately, seeking a handhold even as he felt himself falling, falling, falling into the dark.

There was a beeping in his ear when he came to. It was the power supply's warning signal. It must have been damaged in the fall. He couldn't feel his feet and his fingers felt as if they were made of pure ice. He realized that he was lying on his side. He rolled over so that the

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pack provided a back rest. He willed his left leg to move as he stared at his boot. It didn't move. Nor did his right one. He couldn't even feel the pressure on the backs of his legs. Strange.

Paul looked around. Behind him was the dark crack in the cliff's face. On either side was a steep slope of icy regolith, a shelf formed from the material that must have fallen from the cliff when it cracked. A few meters below his boots was the edge of yet another cliff. Had he slid another few meters he would have plunged over the edge to his death. He'd been pretty lucky, he thought and laughed for having such a foolish thought.

Lucky! His legs were useless. His power unit was shutting down, judging from the shrill warning beeping that still sounded in his ear. Once that went he would succumb to the cold, or lack of oxygen, or simply sheer exhaustion. The sharp drop-off would have been a merciful end instead of this slow creeping death.

Paul slumped, defeated despite all he had done. He had let his mother and the others down after all. He would die alone, here on this ridge and they would die waiting for him as their emergency systems ran down and finally failed. No doubt Dolores would curse herself for encouraging his foolish attempt at rescue. She would die cursing him for being so immature. She would curse him for failing her.

One twist and you can end it all, the green dragon whispered temptingly. Paul reached up to touch the fastenings on his helmet. He would die in seconds when the air rushed from his lungs and his skin froze. He gripped the helmet's fastener between thumb and finger and took a deep breath.

Go ahead, what are you waiting for? the green prompted. But Paul's hand would not move. He didn't have the guts to end it all. He didn't have the courage to admit defeat.

If you do this, the blue dragon asked, *will your mother cry over you? Will she know how very much you love her?*

How could she *ever* know? Paul cried. *You* were always the one she loved. *You* were the one who stood between us. *You* were the one who kept me in the role of a child who could never measure up!

Before the blue could respond to his accusations a strobe of blue-green shot from the station toward the cliff away off on his right. Of course, Paul realized as he recognized the Wholephore link's signature, he must have come far to the left of the tower. He'd drifted more and more off course as he came along. He'd probably been heading toward the wrong one of Jupiter's bands all along. Well, that wasn't surprising, considering the other ways he had screwed up on this trip.

He wished there was some way he could let Marcus know of their problems, of their desperate need for rescue. He wished that he had a laser to flash at them, a signal to let them know his location. If he could just do that . . .

But there was no way that he could hope for people from Marcus to reach him in time. The beeping had stopped, meaning that he had only ten minutes or so remaining before the heaters failed and the cold would begin to penetrate his suit and turn him into a frozen corpse. It mattered not that he still had enough oxygen to sustain him for an hour, the cold would kill him before then.

Oxygen? Yes, you have more oxygen than you need, so why not use it for some useful purpose? the blue dragon suggested.

Paul thought furiously, his mind clearer than ever before as the chill began to reach inward. After only a moment's thought he came up with a solution. He could survive for about five minutes on the suit's air and that was long enough to do what he wanted.

First, he carefully wrote out a message for those who would find him, telling them of his mother's desperate plight at

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Greeley. When that was done he began his final preparations.

With calm assurance he detached his pack and pulled it around into his lap. It was a matter of seconds to remove the recycler and set it on the ice beside the pack. He used his gloved fist to smash a hole in one end and expose the charcoal mixture inside. He next disconnected the twin hoses of the oxygen supply and switched them so that the flow was reversed. This way the unit would send the oxygen back into the recycler and across the charcoal mix.

Paul pulled the battery leads out and positioned them above the hole in the canister, said a brief prayer, opened the feed valve on the oxygen supply, and touched the wires together.

A bright spark jumped across the gap, but nothing else happened. Paul wondered if he had miscalculated. Had he misunderstood the chemistry involved? He touched the wires once again. And a third time.

There was a sudden gout of flame that shot ten meters up into the darkness, a brilliant blue flame that threw the entire area into stark relief. Why blue, Paul wondered, and then realized that the tiny amounts of methane in the atmosphere must be burning as well.

Paul laid back on the ice as the blue flame danced above him. In the flickering shadows he could see all of the dragons dancing, only this time they were dancing in celebration at his joining them.

They were all there, Paul imagined as the cold penetrated his suit and began to creep up his limbs. But the cold was his friend, he realized. The cold would turn him into an ice dragon so that he could join the others who dwelt in the depths of Europa. Yes, he could see the dragons clearly now. He could hear their sweet voices as they sang of Europa's promise and the terrible price she extracted from those who tested the ice.

The blue dragon and the green danced around him, drawing closer and closer. For the first time he could see them clearly. Both had his father's face.

Paul could clearly hear the dragons' voices over Europa's sweet song now.

You have done your best, the blue said. *You have conquered the ice, far beyond my—our—expectations.* The blue did a dance to display its pride at this son who had braved the icy wastes to the end of his resources and never gave up in defeat.

Paul noticed that he could no longer feel his arms. Was this a step in the process of being converted to an ice dragon, he wondered? He marvelled at the ease of this transformation as the air grew close and his breath faltered. His heart swelled with joy at the blue dragon's final acceptance of him and he rose to join the dance.

And, as he did so, he began to cry for his poor, dead father.

The rose dragon slid gracefully into the dance. Her delicate movements were full of forbidden promise and loving comfort. She drew closer and closer, singing her lovely, enticing song as she wrapped her sensual coils around Paul, squeezing him in her warm embrace, encompassing his body, and giving him the release and rest that he needed so desperately. As the blue light faded and the darkness rushed in, Paul could finally look directly at the rose dragon.

She had his mother's face.

"Are you awake, Paul?" she said.

Paul jerked. The voice was so different, so harsh compared to her earlier song. What had happened? It felt as if his skin was on fire, as if a thousand pinpricks were spotting his body. "Wha . . ." he said in confusion.

"Take it easy. It was touch and go there for while but you made it."

"Father?" Paul asked as he tried to force his eyes open and see the dragon's lair. Surely the rose dragon had brought him to her den to live with her forever and ever. But, why did he feel his arms? Dragons didn't have arms!

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A sharp smell of disinfectant and medication assailed his nostrils. In the background he could hear other conversations and the clink and rustle of many people. Then he felt the bandages across his face and the wrappings that covered his hands.

He still couldn't feel his legs.

"They found you from the flare you set," his mother's voice continued. "That was very clever, using your pack as a flare to let them know where you were."

"They rescued you?" Paul mumbled. For some reason he still couldn't seem to open his eyes. His message had worked! His sacrifice hadn't been in vain!

"Oh yes, the rescue party arrived about twenty hours after the quake," his mother continued. "They would have gotten there sooner but there were a half dozen other habs that were affected. We weren't the last, nor the first. They sent out people to find you right away."

"Dolores?" Paul said. "Is she all right?"

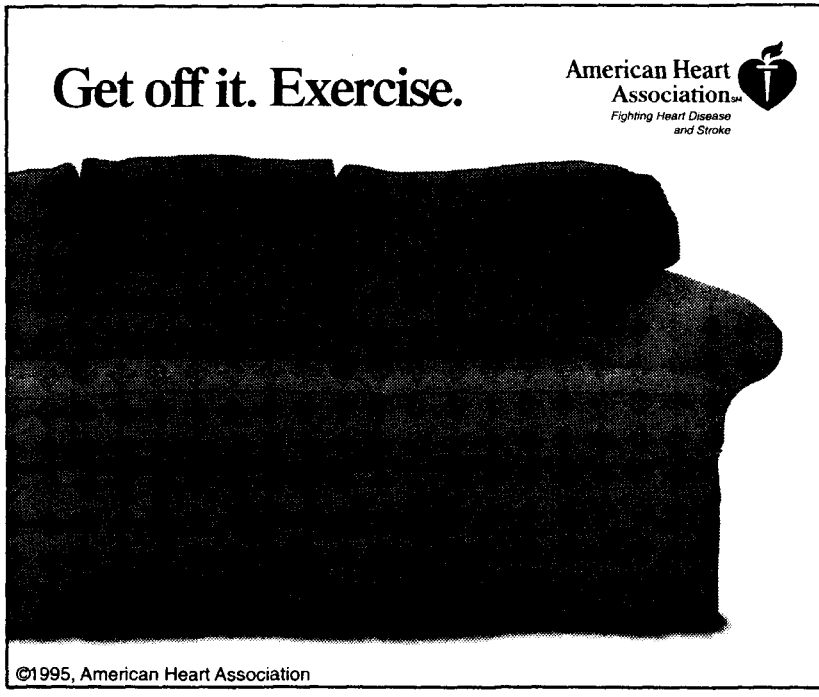
"Yes, and her boyfriend says he really wants to thank you for the help you gave her. She is so proud of you—wants to make you her honorary little brother, she says."

"Wonderful," Paul grumbled, starting to feel more like himself. *Little brother* indeed. What did she know anyhow? He didn't need her anymore. He didn't need anybody anymore.

"It's such a pity," his mother said, shaking her head sadly as she stroked his cheek. "Such a shame that you had to go through all of that for nothing."

Nothing? How could she say that, Paul wondered? His trek hadn't been in vain. *He* had won against the worst that Europa had thrown at him! *He* had defeated the ice and the dark! He had conquered his inner fears!

He had danced with dragons.■



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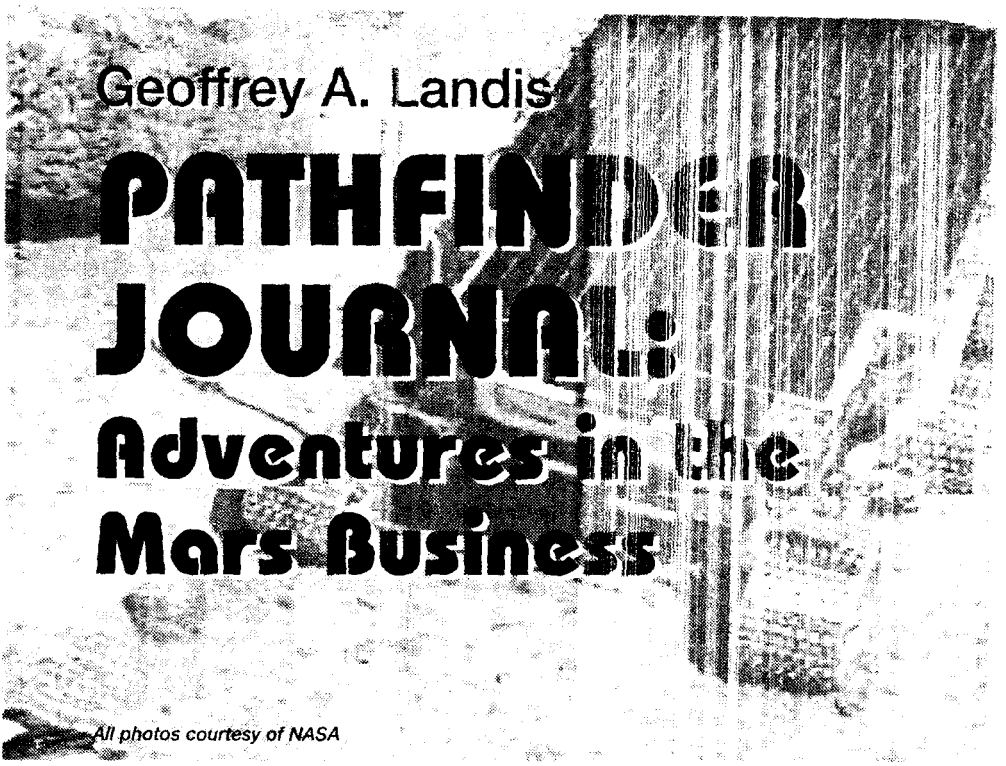
Geoffrey A. Landis

PATHFINDER JOURNAL: Adventures in the Mars Business



All photos courtesy of NASA

The spacecraft is silent now*, shut down for the winter, and the Pathfinder mission is over—or at least the spacecraft operations are over; the science analysis is just beginning, and the science assessment group meetings are as boisterous and argumentative as ever. Possibly even more so. It was an incredible summer.

A year ago, hardly anybody seemed to be interested in what I was working on—something technical, something boring that has to do with NASA. But for one brief summer, everybody in the world seemed to know about Pathfinder. Everyone has seen the pictures from Mars: the cantaloupe sky with slope-shouldered mountains on the horizon, the dusty, oddly shaped rocks, the boxy six-wheeled rover that people seem to find so "cute." Nobody had to have airbag landing systems explained. Neighbors stop me on the street to tell me that they saw my picture in the paper; friends I haven't heard from in 20 years e-mailed to say they saw me on television.

It was a summer that there just wasn't time. There was always something happening, data to be analyzed, new data downlinking from Mars, command sequences to write. It has been the busiest summer of my life, and there are big holes in my journal, whole weeks with nothing written down. I mostly wrote during meetings, or stole a few minutes after lunch to scribble down a few quick observations.

Mostly, my Pathfinder notebook contained numbers: data, calculations, analysis. But in between the tables of data and the schedules, when there was a little bit of spare time, I jotted down what was happening.

This is what it was like.

11 June 1997: ORT-7

This is the seventh Operational Readiness Test for the Mars Pathfinder. It's the third such test with the science team participating as well as the mission

**Ed. note: written ca. January 1998*

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engineers. An ORT is a dry run, essentially a practice of what we'll do when Pathfinder lands on Mars, to make sure that everything runs smoothly when the real landing happens.

Today is the third day of the ORT, and also the simulated landing day; the first two days consisted of meetings and planning. It's 1 P.M., Pacific time, and the simulated spacecraft has, in fact, already landed on simulated Mars. But my shift doesn't start until 3 P.M., with a pre-downlink meeting of the IMP camera team.

IMP is the name of Pathfinder's camera, short for "Imager for Mars Pathfinder." We use acronyms a lot here at NASA—we must love acronyms, we use so many of them! After a while you do get used to it.

I've become so accustomed to hearing the acronym "IMP" that it's hard to remember that, at the first meeting where I heard the term, I had no idea what it was. In fact, I thought that "IMP" must be an ion microprobe (another type of scientific instrument that might plausibly have been put on a Mars lander). I was listening to an "IMP" presentation for almost fifteen minutes before I realized that it wasn't an ion microprobe. I had to raise my hand in the middle of the meeting and ask. It's hard to believe that they were talking for fifteen minutes and never once used the word "camera." Camera sounds too down-to-earth, I guess!

The team meetings are a lot more crowded than they were at the last ORT. Matt Golumbek just popped in and announced that the landing—the simulated landing—was successful. There's a software glitch which they're tracking, but the spacecraft is okay.

The science operations groups—we call them SOGs—work out the scientific schedule for the Pathfinder spacecraft: what it will do each day, where the rover is sent, which objects the IMP photographs with which camera filters at what time of day. The SOG that I'm on is Atmospheric Imaging Research, or "AIR." This was originally called Atmospheric Aerosols, and my dust-settling experiment fits the aerosols focus, but the first thing that the group did after we met was to decide on a new name. After fifteen minutes, I finally came up with the acronym "AIR," and Pete Smith said, "AIR Mars! Yes!"

So I guess I'm the one responsible for the acronym this time, and now other people will be confused. But at least the AIR Mars group studies, well, air.

One of the things I've been pushing for has been full-sky imaging. I'd really like to know where every photon hitting the surface of Mars comes from, and what color it is. The rest of the group only wants enough data to learn the optical properties of the airborne dust. But for the solar array analysis, I'd really like the full sky. At the AIR meeting Monday, Mark Lemmon said, well, OK, that's a lot of downlink, but why don't you calculate the unit vectors for the camera pointing? That's a start.

I did this calculation last night. It turns out that it requires 128 frames, that is, 128 separate "snapshots" with the IMP camera, to cover the whole sky. Of course, we only need half the sky—the half to the left of the sun will be the same as the half to the right. Still, 64 images is a lot of data, even if it can be highly compressed—and I'd like all 13 camera filters, too!

Another thing I wanted to do is to look for halos: a ring around the sun with a red edge—the signature of atmospheric ice crystals. Mars is too cold and has too low atmospheric pressure for liquid water to exist, so the clouds on Mars must consist of ice crystals. Turns out that the rest of the AIR team had similar ideas—Nick Thomas, our team leader, wants to look for not just a halo around the sun, but also pillars and sun-dogs, other ice-induced apparitions in the sky. Mark Lemmon also had an interesting comment—he

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said that he'd like to make a sunset or sunrise shot. At sunrise, the sky will be red, but he thinks that the sun will be blue—the red light is strongly scattered by the red Martian dust. It would be an interesting shot, if it really is true!

JPL is predicting that there will be a thousand reporters covering the Pathfinder landing. That's incredible. It will be a media zoo. To allow us to do some science, the press will not be allowed in the science area; they will only be allowed in the Space Flight Operations Facility with an escort. We will need three different badges to get into the second floor of the operations facility, where they will be running Pathfinder: our ordinary NASA badge to get us in to JPL, a badge for the Space Flight Operations Facility, and then a separate Pathfinder Operations badge to get to the second floor. My badge is yellow, for essential personnel—it means I can get in on landing day.

June 12, 1997

Computer reset again.

The main thing we are learning from this ORT is that the computer sure does reset a lot. The engineers say that this seems to be a problem with the testbed, and it "probably" won't happen on the actual spacecraft. I sure hope they're right!

How I Got Here

Seven months ago—it takes seven months to get from Earth to Mars—it had been a night launch. The launch was a spectacular sight, with the Delta lighting up the Florida sky and the solid-rocket boosters sparkling as they fell away into the ocean. Pathfinder would hit Mars, one way or another, on July 4.

We weren't the only mission aiming at Mars this year. Months ago, the Russians had already launched and failed, their Mars-96 spacecraft, the largest and most complex planetary mission ever launched, spread in flaming pieces across the Pacific Ocean and South America. Behind us, the crippled Mars Surveyor was cruising toward its own rendezvous with the red planet. But for now, we were in the spotlight.

My involvement with Pathfinder actually dates back to before it was named Pathfinder, when the mission was still called Mars Environmental Survey—MESUR—and was to be a network of eight or twelve tiny landers that would be spread across the globe of Mars. The first of these, the MESUR Pathfinder, would prove the feasibility of the airbag landing concept; after that, four spacecraft would be sent to Mars every two years, to build up a global environmental survey net across the full face of Mars.

The full survey mission never got approved—too ambitious, too expensive—but the MESUR Pathfinder spacecraft, renamed simply Mars Pathfinder, became the first of the new "Discovery" series of spacecraft, little space vehicles to replace the old NASA strategy of huge, multi-functional robotic probes with tiny, inexpensive dedicated probes. "Think small, in large numbers." The idea was to build them small, use military-grade or even commercial parts instead of space-qualified parts, accept risk. Class-D, in NASA parlance. "A Class-D mission, but with Class-A visibility," as Tony Spear explained it. The Pathfinder would be half the size of the 1976 Viking landers, and a tenth the cost.

My background is as a solid-state physicist, an expert on design of photovoltaic devices—that is, solar cells.

Pathfinder is not my first experience with space hardware. A prototype of a solar cell that I'd designed flew on the shuttle-launched LDEF spacecraft—Long Duration Exposure Facility—back in 1985. Designed to spend ten months in orbit, as a result of the Challenger disaster it had taken over five years to bring back. Over those five years, the thin Kapton film that held my solar cell in place had been slowly eaten away by atomic oxygen, and when the LDEF was

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picked up at last by the shuttle robotic arm, my solar cell had gracefully floated away.

Not all space experiments are successful.

And now, by a quirk of luck, I was a contractor to NASA. Since I also knew a lot about Mars (thanks to my interest in science fiction), I'd become the local expert on operating solar arrays in the Mars environment.

The questions I faced were, will solar arrays still operate in the dusty environment of Mars. Is there enough sunlight? Will the environment degrade the performance?

Me posing with the Sojourner rover, pointing to my experiment on the front left corner.

The Mars solar power studies I collaborated on showed that even in a Martian dust storm, there would still be enough power getting through to keep a spacecraft alive. Path-finder would be the first solar-powered spacecraft on the surface of Mars—the Viking landers had used radioisotope nuclear generators, not solar arrays—and my power system studies were a part of what made Pathfinder possible.

While the idea of a Mars global dust storm may call to mind a spectacle of howling winds and driving sand, the actuality is rather tame. The Martian atmosphere is tenuous, less than a hundredth as thick as the Earth's, and even at a hundred miles per hour it would hardly howl; it would feel, if you were standing in it, like a light breeze. Over most of the planet, a dust storm is signaled by no more than a gradual darkening of the atmosphere. "From the surface it would look like L.A. smog," somebody once explained to me. "The atmosphere just gets a little thick."

The next question was, would dust settle onto the solar arrays and degrade them? I was surprised to find that nobody had looked at this issue before, so I made a quick calculation based on the best measured data on the properties of Martian dust. I concluded that, no, deposited dust shouldn't be a problem for the Pathfinder's projected 30 day mission, even if it landed during the middle of a global dust storm.

The two-year-plus MESUR mission, though—that could be more of a problem.

We needed data.

On the first trip I took out to the MESUR project office, back when Pathfinder only had a handful of people on it, I had two instruments to propose. One was a fly's-eye sky camera, designed by my collaborator Joe Appelbaum, that would tell us the sky brightness on Mars. When the atmosphere is dusty, sky brightness contributes more to the solar power than the direct sunlight; measuring sky brightness would validate our calculations. The second instrument I wanted to put on Mars would measure how much dust deposited on the solar arrays, using a solar cell and a sensitive quartz-crystal microbalance.

The sky camera never made it. The dust deposition monitor, renamed MAE, for Materials Adherence Experiment, was tentatively accepted, although not

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without a lot of meetings; it later got bumped off the lander and ended up on the rover.

The Sojourner rover is about the size of my laser printer, and our challenge was to build an instrument that didn't interfere with any of the other rover systems and weighed almost nothing. I built the first working model myself, but I was lucky enough to have Phil Jenkins—an engineer who had started out as a student in our branch—design the flight unit; he made a nitinol-based actuator that was smaller and lighter and more reliable than anything that I could make. The fact that it works so well is more of a testimony to his careful attention to engineering than to my fanciful designs.

And now it's on its way to Mars.

The sky of Mars is of some considerable scientific interest. The sky is not empty, but filled with suspended dust particles. The dust particles are tiny—far smaller, for example, than the particles that make up talcum powder—and give the sky of Mars its characteristic pink color. From the way that the dust particles scatter light, you can tell a lot about how big the particles are and what they're made of; and this is important, since by absorbing sunlight during the day and reflecting heat during the night, the atmospheric dust is the primary driving force behind the weather systems on Mars. Airborne dust determines the climate of the planet.

My interest in dust, though, is more practical: to understand the performance of solar arrays on the surface, I need to understand dust in the atmosphere. I am keenly interested in how the solar arrays are working—are they following our theoretical predictions? Are they degrading? However, we want to know more than just how this one solar array performs. What would happen if we had solar arrays pointed in a different direction; what if they faced East, or were tilted South? If we used different types of solar cells, would the performance be better or worse? If there was more dust in the atmosphere, how would the performance change? Looking at the power output of the Pathfinder array is fine, but we really want to know the direction and wavelength of every photon which reaches the surface of Mars, and we would like to know this at every time of day, for clear skies and dusty skies and every type of sky in between: an all-sky survey.

The IMP camera on Pathfinder is an ideal tool for this investigation. It is actually a black and white camera, but it manages color with the use of a dozen different filters to examine light in wavelength bands from blue to infrared. It is perfect for my use, except for one detail: the geologists already have dibs on using it. Imaging the sky takes a lot of camera time—there is a lot of sky, and I would like to look at it all.

July 4: Landing Day

At JPL. This time it's not a test, but the real thing.

I am in the science operations area, watching the same television picture everybody else is watching, the same I would have watched if I were at home—there is nothing we can do except watch. At the science working group meeting this morning, the last meeting before the landing, Matt Golumbek quoted: "At launch and at landing, science and religion coincide. You've done all you can, and now all you can do is pray."

Landing—

—now.

—Now the downlink reports a signal from the spacecraft. It worked—the spacecraft is not dead! Everybody is clapping and cheering. In the TV showing the mission control, you can see everybody embracing. It worked!

The spacecraft is transmitting a surface semaphore. The base petal is down—the spacecraft landed upright. Everybody is cheering.

So many things could go wrong, but

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it didn't break! It worked! All those months I've been holding my breath, and it worked! Pathfinder is down, and it's transmitting from the surface of Mars!

YAHOO!! We're on MARS!

Too many things could break, too many things could go wrong, the airbag landing is too far-out. But it worked, it worked!

The semaphore tells us only that Pathfinder landed; it transmits no real data. To learn more, we will have to wait for sunrise on Mars. We have hours to wait before the solar arrays open, before the spacecraft locates the sun and the Earth. . . .

The Bouncing Ball from Outer Space

Pathfinder's mission wasn't actually science at all, it was engineering. Pathfinder was to test out a new landing technique: airbags.

The plan was to come into Mars' atmosphere directly from Earth. This was completely unlike the Viking lander mission, which loitered in orbit to deliberate over a landing spot. Pathfinder would hit Mars on July 4, whether we were ready for it or not. A heat shield and a parachute would slow it down some—but not much. Mars' atmosphere is thin, and parachutes are only of limited use in it. Small solid rockets would fire moments before impact, and then, 20 meters above the surface, the parachute bridle was cut, and Pathfinder dropped.

And bounced.

The thing was a bouncing rubber ball. The first time I saw the films of the Pathfinder's drop tests I was flabbergasted at just how well it bounced. Picture a spacecraft the size of a Yugo, surrounded by giant beach balls, bouncing as high as a five-story building, and rolling as it bounces across the Martian landscape.

This is not your father's spacecraft.

The design spec was that our experiment was to be able to take 100 gravities of impact.

Before landing, we had a map mounted by the science work area, an orbital photo of the landing site with the error-ellipse for the landing overlaid on it. Justin had taped an envelope to the map, and everybody put a dollar in and stuck a dot on the map with their guess as to the exact landing spot within the error ellipse.

The choice of landing site, as always, was made after a war between the scientists and engineers. The scientists wanted an exciting site: mountains, boulders, canyons to explore. The mission engineers, on the other hand, want a place that is absolutely flat, with no hills, no large rocks to tear the airbag, and most certainly no cliffs. The result was a compromise. They found a site from the Viking photos that looked like the outflow channel of an ancient catastrophic flood, where they hoped they would find rocks that had been carried hundreds of miles by the floodwaters.

And then the mission engineers found a site within that area where the terrain looked completely flat and featureless. The site would be boring, we knew that right from the start.

We were wrong.

The First Images Come Down

3:30 P.M. We have a signal from Mars!

Downlink: the spacecraft has found the sun, used the sun's position to calculate where the Earth is, and pointed the high-gain antenna. The big monitors over the science work area come to life, and the first images from Mars start to appear—black and white images of the airbags, at first. As the first image appears, suddenly the intercom in science operations stutters on, and the Beatles blast across the room, playing "Twist and Shout." Somebody up in flight control has a rock 'n roll sense of style. "Twist and shout" is exactly the feelings of the scientists; everybody is clapping and cheering.

My God, that's Mars. It's not a test!

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This is real! Now there's an image that shows the surface outside the airbags, and the geologists are going crazy.

The room is crowded, everybody is talking at once, and I scribble down what the other scientists are saying, writing as fast as I can.

"Oh, look at that." "Oh, man, are we lucky." "That's incredible." "That's one big rock." "Ooh." "Look! It's a hill." "Scenery!" "We got Martian Alps in the background!" "Damn!" "Oh, my goodness, look at the drift material." "Gosh." "Almost a balancing rock." "The rover guys are going to have a real time driving this. It's a real test." "It's clear the other direction. One side is easy, one side is, uh—" "The rover guys are nervous."

This is Mars, live from Pathfinder! I'm wandering from spot to spot, staring over shoulders, staring up at the wall-mounted monitors, scribbling notes as fast as I can write. On every computer people are downloading images; on all the monitors the images flash by as fast as they are downlinked.

"What directory are you in? We need to get an image to the Vice President." "Here's a good one." "Yeah, that one." "Is that the first one? He wants the first one." "The Vice President is waiting for this—give me a time." "Fifteen minutes." "No, ten." "The Vice President wants an image right now, and we can't get anything out of the directories."

Boring. There's more excitement elsewhere.

"Oh, wow—look, there's the top of a hill. You can see some banding. It could be layering, it could be terraces, it could be differential erosion."

"Not a bad landing site," says Matt Golumbek.

Matt is smiling; this is his triumph. "Not bad" is an understatement, and he knows it. *"This proves that Viking made a mistake. What's amazing is the variety—hills to look at, rocks to look at, sand to look at. You want to go out there and explore. I don't know where we are, but it's a damn good place."*

Matt, chief scientist for the mission, was the one who had made the final choice of the landing site—and had to defend it in endless review meetings from criticisms that it was too rocky, not rocky enough, too dangerous, too boring, too flat. Everybody else is still talking at once:

"Holy smokes." "Look at all the rocks."

"Viking could never have landed here—too many big rocks."

"This is great! Let's do some science."

"Mars never looked so good."

My notes: Striations on one hill. Layered rock, a pockmarked rock. Heterogeneous fines. A large field of boulders.

"Mike? Are you doing any ranges?"

"I can—I'm having some trouble, the labels change."

"This looks like a familiar place. I think I've been there."

"This is too cool."

"That must be that big streamlined island."

"We've got to fight for the insurance pan—we've got so many distant objects."

The "insurance pan" is the high-resolution 360° image taken before the camera is deployed—a ground's-eye view of the site. It's called the insurance pan because there is some lingering worry that raising the mast, which goes off with a serious bang, might kill the camera. The image is "insurance" in case the IMP breaks, and the flight plan is to erase it after the camera is deployed and functional, to free spacecraft memory. By saving the insurance pan, stereo images could be put together with the full height of the mast for a stereo baseline—allowing stereo viewing of much more distant objects.

"We're going to 11 kb next sol—there will be no problem," says Matt. The radio link from the spacecraft is so good, they will be increasing the data rate.

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"You want a landing site, I give you a landing site!"

"What is that? Unbelievable!" "So many things to look at, it's hard to guess." "Is the airbag on the rover petal?"

The intercom announces a meeting: "This is flight. The move-petal meeting has been moved to 5:30 in the conference room."

"Can you believe we're experiencing this?" "No—No." "Can you believe this? This is incredible!" "What a block party!" "Did you get slopes for the front and back?" "Can you write a caption for the mission-success pan?" "Is that hills, or are those craters?" "We think they're hills." "Absolutely astonishing."

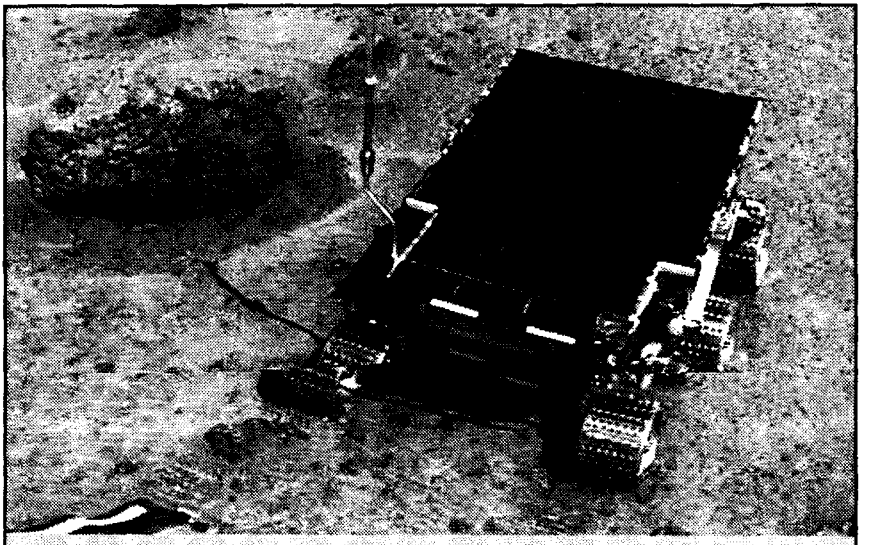
"We're at the boundary between a smooth area and a rocky area. We're not just good—we're lucky."

"I love those hills in the background—it's the sphinx."

"Not a good site," says Matt. "It's excellent."

While the scientists are ecstatic about the images, the engineering team, looking at the same images, sees problems. The next operation is for the Sojourner rover to roll off of the petal, but the images show that both sides of the petal are covered by loose fabric from the deflated airbags, blocking deployment of the exit ramps. This is what the move-petal meeting is about: the rover team has proposed a fix. They want to use the petal deployment motor to lift the rover petal up off the ground, retract the airbag, put the petal back down, and then command another series of pictures to check that the retraction has cleared the ramp.

This astounds me—in all of the ORTs and tests, nobody even mentioned that such an operation might even be possible. But they try it, and, surprisingly, it works—the front ramp is clear, and in the last uplink of the day, the rover is commanded to drive off the ramp and onto the surface.



Sojourner on Mars. The rock to the left is "Barnacle Bill."

1:00 A.M. After the day's data has come down from Mars, the experiment operations working group meeting is convened.

The first report is from the flight engineer, Guy Beutelschies, with a report

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on what the spacecraft did today. "What did we do today?" he says. "We landed on Mars."

Everybody applauds.

"The lander's been kicking butt today. It's pretty good."

And everybody applauds again.

I'm not tired, even though that's 3 A.M. Cleveland time, and I got up early. It's been a long day, but I'm still not ready for it to end.

There's a communications problem between the lander and the rover, we are told. This is why I haven't gotten any information from my MAE experiment yet.

The rover is being recalcitrant in communicating with the lander. They are not sure whether the rover has received any of its commands.

This is something to worry about, maybe—could it be that computer glitch from the ORT, but this time with the real Pathfinder, on Mars? Getting the rover off the petal is not optional—until it drives off the petal, and uncovers the solar array, the lander won't get enough power. But it's still early in the mission—lots of things to try.

July 5: First day on Mars

One day down on the surface of Mars, and already we know where we are.

The landing spot has been nailed. *Tim Parker and Mike Malin have been leading a group looking at horizon features and matching them up with views from orbit. We are slightly above and left of the small crater—the two mountains in the distance are the streamlined islands to the south.*

Justin Maki wins the betting pool to guess the landing site.

3:30 P.M., morning on Mars. Downlink. The rover is talking! The MAE worked! It didn't break! We've got an experiment on Mars! The QCM sees dust—the MAE solar cell sees dust. The dust may be from the airbag retraction dragging over the surface.

My MAE experiment is a nice experiment, for its size, which is about as big as an "Elvis" postage stamp. It features, however, a tiny piece of unsupported glass about the size of a fingernail, and I've been biting my own fingernails hoping that the airbag landing didn't break it. The communications glitch between the lander and the Sojourner rover didn't make me sleep any easier! The first measurement was at noon on the day of landing, just after the lander opened up and radioed back to Earth, but we didn't learn what happened until today: it did work, it didn't break, it's giving data.

I have an experiment on Mars!

This is the moment I've been working toward for the last four years. It works!

July 5: Rock Names

8 P.M. I was in a meeting with a few of the geologists naming rocks. The geologists have pieced together a wall-sized mosaic of the view from the lander, and taped it to the wall of the little conference room, the one we tagged the "fishbowl" because it has windows on all four sides.

It's easier to figure out what people are talking about if the rocks have names—it would be hard, for example, if we only referred to rocks by number or by location or something—"we'd like to send the rover over to rock X450Y009."

So the geologists have been giving rocks pet names. Matt decided that the process should be documented, to make sure everybody knows which name goes with which rock. The way it works is, if there's a rock you think you have a good name for, you put the name on a yellow sticky-note, and stick it on the rock in the mosaic.

The big rock near the rover exit ramp didn't have a name yet. I said, say, do we have a name for the big guy yet? Mike Malin said, "No, but we do now—go name it 'Big Guy'." So I took a closer look at it—it looks just like the head of a bear, so I said "Yogi Bear." Mike shortened that to "Yogi," and put a sticky on it. I wanted to name the funny black one on the horizon

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"Horsey," but Mike went for "Couch," thinking, I guess, that it looks a little like a psychiatrist's couch. "Wedge" was obvious, so I put a sticky on it. Another nearby one looked a little like an animal head, maybe a chimpanzee, so I named it "Chimp."

(Note later—from the deployed view, this is actually two rocks, and barely looks like a chimp at all!)

The geologists had the two mountains on the horizon named "Double Hill." That's a little boring—I suggested "Twin Peaks," and Mike reluctantly wrote, in tiny writing, "aka Twin Peaks." They had also put "Far Knob" on the mountain that's so far off in the distance that it's faded almost into sky. I'd been doing an analysis of the dust opacity by looking at how much this mountain was faded, and I've been thinking of it as "Misty Mountain," so I wrote that underneath the name on the sticky.

Next I think I'll try tagging the little triangular one near the lander "Tip of Buried Alien Pyramid"—see if that name sticks!

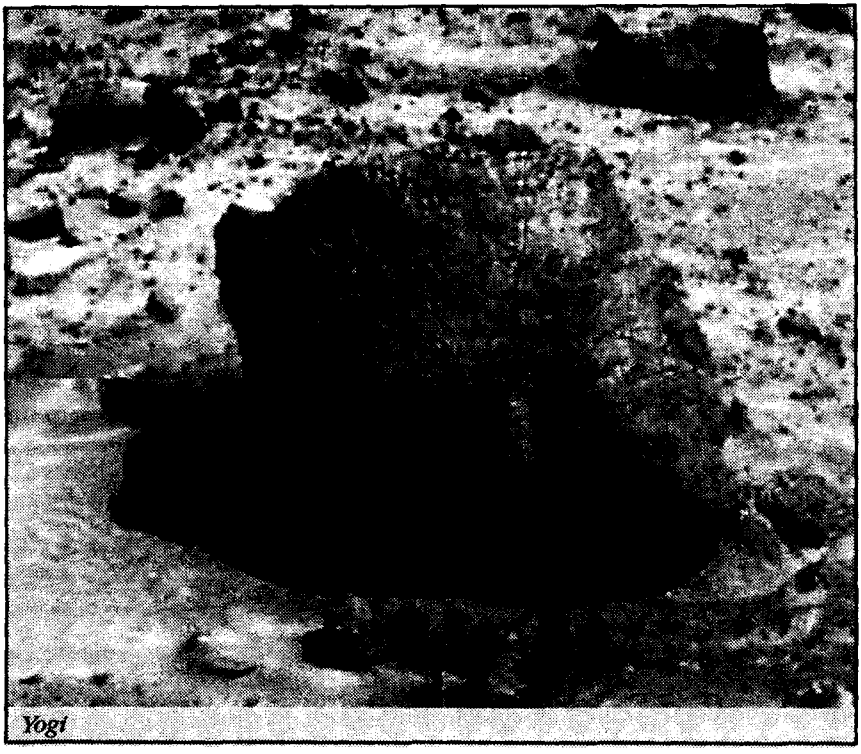
Naming rocks on Mars—what fun!

Ring Around the Sun

10 P.M. The Hubble telescope pictures of Mars show a cloud layer, or maybe fog, at the morning terminator. I think that if we image the sun through this cloud we should see a really fine 22° ice halo.

It looks to me like the haze is burned off by the sun by 20 degrees past the dawn line. The haze is erratic earlier than that, but definitely burned off by 1.3 Mars hours after sunrise.

Data from ASI-Met (the meteorology team) shows a plateau in temperature during the cool-down at night, indicating, possibly, a release of latent heat by formation of an ice fog at ground level.



Yogi

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So I think it is rather clear that we have at least a thin ice haze, and it's worth looking for the halo.

Did we land at the edge of a dust storm?

Hubble also shows a dust storm in Valles Marineris, not far south of where we are. Might the dust we see from Pathfinder be the tail of that dust storm?

I can make a quick calculation of the amount of dust in the sky from the brightness of shadows: the lighter the shadows, the more dust is scattering the light. My estimate tells me that the optical depth is 0.56, five or ten times higher than the value that the Hubble photos tell us we should be seeing. The solar array power is low as well. In my notebook I list seven pieces of evidence that suggest we're seeing a dust storm, ranging from the unexpectedly large amount of dust we saw deposited on the rover, the large size of the particles, the color of the sky, the fact that the optical opacity of the sky is far higher than the opacity measured by Hubble, and the fact that the dust, in fact, seems to be clearing up as the Valles Marineris storm fades away. It turns out, though, that I am premature in suggesting a dust storm. My conclusions are wrong. There's no storm—the Hubble measurements were wrong (or rather, the interpretation of the data was mistaken, the conclusion of a cold, clear sky was inaccurate), the data suggesting clearing was just noise, and the heavy dust fall we saw on our initial measurement was only a little puff of dust raised by the retraction of the airbags. It turns out that the dust we see is normal for the season on Mars.

July 6: Experiment Operations Working Group Meeting

The meetings come after the day's last load of data has come down from Mars, and the sun has set on Mars. Since Pathfinder operates on Mars solar time, this comes in the small hours of the morning, Pacific time—and later each night. The rover made it off the petal, and the mission is a roaring success.

1:30 A.M.: Now that the rover is off the ramp, Matt says that the engineering is done, and from now on, all the press conference will be science. Up to now, the NASA Select TV coverage has hardly ever showed the science operations area—makes us scientists feel neglected. Or it would have made us feel neglected, if we weren't too damn busy!

When Sojourner came down the ramp, the whole rover operations team was invited to the press conference. This was the first time I've been invited to appear at one of the press conferences. (I'm officially part of the rover team, since my experiment is mounted on the rover. They don't let me drive, though!) *Everybody cheered and clapped. Afterwards, before the science assessment meeting, there was champagne in the conference room.*

Highlights of the science meeting:

Both mountains of the Twin Peaks are banded, but one has horizontal bands, and on the other the bands are angled. There's a lot of controversy among the geologists as to why—some say folding, maybe sedimentation. Mike Malin thinks that the bands are where the upstream island picked up debris, like catastrophic flooding in Iceland.

Barnacle Bill looks like it has a depression, almost a moat around it, as well as a clear tail marked out in the soil behind the rock. There's some argument about whether the tail is fluvial or aeolian. (That is, whether it was caused by water or by wind). *"Barnacle Bill" is an interesting rock covered with odd pock marks. The name is an obvious one—when I looked at it this afternoon in the stereo view, I said, "Hey, it's got barnacles on it!" And the geologist standing behind me said, "yeah, why did you think we call it 'Barnacle Bill'?"*

The pointing of the antenna is superb. The high-gain antenna is pointed at Earth with well under two degrees

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of error, so the communications engineers are going to increase the data rate up to 11 kilobits per second.

This will give us fifty-two megabits of data on the next downlink—a spectacular rate of data. The mission is not going to be data-rate limited very much longer!

Dan Britt says that a camera sequence aimed at taking a high definition, 12-color image of a nearby patch of soil failed because the rover moved off the ramp and onto the soil just before the image was taken. So we have a 12-color, uncompressed image of the rover. Could be a superb publicity shot, and it will show our experiment perfectly. Dan is, however, quite pissed.

The planning meeting closes at five minutes to three—off to sleep!

July 6: Long-Range Planning

7:45 P.M. The first long-range planning meeting—up until now, everybody was just planning for the first week on the surface, and optimistic to hope it would even work. Matt is emphasizing the higher-than-expected data rate, which means that our data queue will be empty soon. Lots of data available!

Planning for Sol seven, a week after landing, is contentious—nobody yet even agrees on the philosophy of what to look for. I suggest the full sky survey—yes!

11 P.M. The download is coming down, a torrent of data. Everybody is much more subdued now; a few cheers and shouts when the deployment of the IMP mast is confirmed, and we verify that the camera is still working from the higher vantage, but not the jubilee of the earlier downlinks.

Look at image S-0074, ID 1495: another striated rock?

A modest cheer when the IMP image confirms that the rover team put their APXS directly onto their rock.

12:30 A.M.: the science assessment meeting. Mike Malin confirms that some rocks have veins, and also banding. In the stereo view, ridge and valley formations are visible, trending in the direction of the flood.

Hank Moore gets up from the floor to give the rover science report. It doesn't seem odd that he is participating in the science meeting from a position horizontal on the floor under the conference table: he was up until well after 5 A.M. last night (when I went home) and was up early to prep for the 10 A.M. press conference, and then we worked all day. A tough schedule.

The working group's agenda starts with the report from the project chief scientist. Matt looks up, and reports: "One happy dude."

Then he goes back to looking at his data. A very brief report!

July 15: Naming Rocks (II)

Back in the science operations at JPL, after spending a week back home while Phil took over my shift.

The science area is a lot less crowded now, a week into landed operations. People are no longer running eighteen and twenty hour shifts. Even the hardest-working scientists are going home to sleep for a while now.

My naming Yogi has set a trend; at least a dozen other rocks now sport names of cartoon characters, from a nearby rock named "Scoobie Doo" to a whitish rock tagged "Casper." Yogi has been set to be the next target for the rover, and I've been watching with an odd proprietary interest as "my" rock is featured in the prime-time TV news.

Matt's postdoc student Nathan was named as the Czar of rock names, to give some formality to the naming process. If he decides that the name fits, he keeps it; if not, it's gone.

My proposed "Tip of Buried Pyramid" got shortened to just "Pyramid." Oh, well, I suppose "Tip of Buried Pyramid" was too long anyway.

I tagged a group of three angular, al-

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most square small rocks near Yogi "The Dice." Close to the lander there's another one that's very angular, I tagged it "Buried Brick," which is just what it looks like. And two more that look like animals: "Otter" and "Baby Otter."

People outside of the lab are paying attention to the rock names. Among the cartoons that are beginning to show up on bulletin boards and office doors is one from the illustrators at Hanna-Barbera that showed up one day on the fax: the cartoon characters are on Mars, and Boo-Boo is commenting, "It's an honor to have a rock named after you, Yogi." I photocopy this, and paste it in my notebook.

Command Approval Meeting

The Pathfinder and Sojourner are complicated robots; you program them, and they do what you tell them to do. After the operations working group meeting, the uplink shift has about seven hours to write the sequences to be sent to Mars to program the next day's operations. The command approval meeting is the last meeting before the uplink, to make sure the sequences do what they are supposed to, and don't do anything that would damage the spacecraft. After working all night, the command approval meeting is likely to be even more filled with jargon than the working group meetings. I'm on downlink shift, and so I don't usually sit in on the command approval meetings. When I do, the conversation is opaque, almost surreal—

"Chris, there's no 267 in the sequence?"

"That's right."

"Do you still have the redlines from the 02 and 03 sequences?"

"02 had some peculiarities. What was it you found in the 02?"

"02 has an extra receive."

"That's OK. What about the low DPT? Anybody figure out why 02 fires into a low DPT?"

—and so on.

July 16: Anaglyph

On the wall of the fishbowl has been posted a huge stereo mosaic of the view from the lander, an anaglyph in red and blue. Over and over I walk over to it, put on the cardboard red-blue glasses, and just stare at it. It's so different in 3D, rugged and corrugated.

Looking at the anaglyph is almost hypnotic; you feel you are there, you're really on Mars. You can get lost in it.

Staring at the anaglyph, there's a whole ridge of rocks right nearby, looks like a stegosaurus's back. You can't see it in the ordinary 2D images, but it stands out in 3D. If it hasn't been tagged, I'll name it "Stegosaur Ridge."

July 17: Data

4:30 P.M. I've got data.

I'm walking through the woods. Just east of JPL is a walking trail up the arroyo into the National Forest. The day is warm and the trail alternates between dusty heat and tree-shaded cool. I'm thinking about my data. It's taken nearly two weeks for the slow accumulation of dust to build up enough data to analyze. I'm thinking that I can analyze it enough to tell something about global sedimentation patterns on Mars, thinking this could be enough for a paper.

It's been a long day, fourteen hours in science operations, and then a two-hour hike. But I can't imagine what I'd rather do. Mars Pathfinder is already yesterday's news to the newspapers, the TV, the internet pages, but to us it's barely begun, and there's no end in sight.

I've got data, real good data. Who could ask for anything more?

July 19: IMP Planning

Problems with the downlink from the lander today. The downlink from the spacecraft often is spotty on weekends—too many people off-shift at the deep space network.

None of my data has come in, so I'm catching up on my journal.

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I've been requesting camera time for the all-sky survey since the first day on the surface, and each day the request has been put off in favor of more urgent projects. In the mean time, I've been refining the all-sky survey, and have come up with an abbreviated survey which can be done with less than half an hour of camera time. This consists of sixty-four frames, which successively pan from side to side and then upward across the sky. I've managed to make a sequence to do this in two colors by using a simple trick—the IMP camera is a stereo camera, and I have chosen a different filter color for the left eye and the right eye. It's not the half-dozen colors that I'd like, but a full survey in six colors would take over three hours, and the time on the camera is simply too precious to spend three hours taking pictures of sky. Writing a camera sequence is not trivial—it requires that you calculate the pointing vector for each frame, and then write a sequence of commands to point the camera, set the filters, select the amount of data compression, and so forth.

I spent yesterday afternoon writing the IMP sequence. This is the first IMP sequence I've actually programmed. It required 64 vectors, each one required to be correct to 8 decimal places. I had already calculated these on my Excel spreadsheet. When I finally finished programming the sequence and was ready to go back (it was a long day!) I gave it to Bridget Landry [the uplink engineer] to test out by running it on the IMP testbed.

When I got in the next morning, I found on my work area that she had left me a note—she'd corrected some minor errors, and found one place with a vector that I needed to correct, but it was mostly OK. Not bad for my first sequence, I think.

At the Experiment Operations Working Group meeting it got approved to be put in the schedule to be sent to the spacecraft.

Think I'll take a hike.

A closer view of Yogi from Sojourner's cameras. Still looks like a bear!

July 20: A Day Without Data

1:15 P.M. No data. I got in by 4 A.M., checked LabView, no data from the first downlink. So I messed around, took a dawn walk around the lab (watched the deer doing their morning feeding), came back for the 7 A.M. downlink—nothing.

Checked the conference room at 8 A.M.

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The flight operations team was having a meeting, trying to troubleshoot why the downlink didn't come down. They had gotten a "blip" from the spacecraft the second time, but no signal.

The meeting lasted three hours. After, Larry Soderblom wondered if the lander was slowly tilting, throwing the antenna pointing off—could it be airbag settling? I suggested that if it were indeed settling, you could see it by looking at the photos of the meteorology mast—the mast photos show rocks, and any tilting would show up immediately by the change in parallax.

July 21

They reacquired the spacecraft today—no, it wasn't tilted, although Larry Soderblom did stop by to tell me that the idea of checking the met mast was a smart one. Instead, it was just a sequence of wrong and mistimed commands. "We shouldn't go joysticking around with the deep space network," Rick says.

At the science assessment meeting, I was picked as one of the three science presentations for tomorrow's press conference, to talk about my dust deposition experiment results. This will be my first formal press conference—too bad most of the media have gone home.

At the very last science meeting before the landing, Matt set out very clear rules for press conferences: informal. No neckties, he told us. Anybody who wears a tie to a Pathfinder press conference will be booted off the science team right then and there.

Works for me—I haven't worn a tie in over ten years.

I don't have a lot to present, really, just a graph of dust accumulation. No pretty pictures. But the data is good data, and I think I can resolve a genuine scientific controversy: where does the dust go when it leaves the atmosphere?

July 22

Everybody tells me that the press conference went well, and I did a good job of making dust seem interesting. Odd—to tell the truth, it had slipped my mind that other people might not find dust interesting.

The high point—around noon I went to the library, and a guy walked past, stopped, turned around, and said "Say, didn't I just see you on TV?" (said he liked my presentation, too).

Martian Time Slip

What's it like? You get up early in the morning, go to a windowless room. The science working area. It's filled with computers, lining all the walls. The computers all have names: sisko, janeway, chakotay, vidiian. (The one I've been assigned has a more boring network tag, alas: MPF8.) The relentless fluorescent light of the science working area tends to fuzz you out; after working for twelve or fourteen hours, you have no idea whether it's sunny outside or the middle of the night.

But that doesn't matter. What's important is what's coming down from Mars. This is it. This is why we're here.

At the science working group meeting, people talking in acronyms, jargon, and sequence numbers: "We're targeting 44 to image an area that's disturbed." "Take out 5044, 5046, and run 5020." Darkstrips, nullstrips. PSG, SOG, APXS, IMP, ASI/MET. To an outsider it would be incomprehensible.

And still, at odd moments, I would suddenly smile: we're on Mars!

An odd effect of working on Pathfinder is that although we are in Pasadena, we are not living on Pacific time—we're on Mars time. Pathfinder is a solar-powered spacecraft, and so our schedules are fixed by when the sun rises over Ares Valles, Mars.

By an odd coincidence, a day on Mars is almost the same length as an Earth day—a mere forty minutes longer. What this forty minutes means, though, is that compared to Pacific Daylight time, the schedules of every-

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body in the science team are slowly slipping later and later. It's the Martian time-slip. Every three days, our day starts two hours later.

Right now I can have breakfast only at restaurants that are open 24 hours a day. And, after eight hours of operations, I have supper at breakfast time, getting odd looks from the waitress as I order a dinner-sized meal at breakfast time. I'm at Denny's right now—"Always open" looks awfully good when you're living on Mars time.

But each day, we are working later and later.

Soon we will be moved back to "normal" time. That will be strange, to be on the streets the same time other people are around!

Rock Names (III)

In science operations, things are calming down. Scientists are going back to their home institutions; the operations room is no longer jammed with excited geologists exclaiming over each image.

My names "Otter" and "Baby Otter" seem to have been accepted, but "Buried Brick" didn't make it. Nobody seems to have proposed another name for that one, though, so I posted "Brick" on the mosaic—maybe that will make it.

I also posted "Duck" and "Duckling" for two rocks that look, well, like a rubber ducky and a smaller ducky—then I saw that "Duck" had already been used for a different rock, so I changed it to "Goose" and "Gosling."

"Stegosaurus Spine" didn't make it for the ridge of jagged rocks. It's really a distinct feature on the anaglyph, and still not named, so I think I'll see if "Dragon-Tooth Ridge" will stick—that's more euphonic, anyway.

July 22: Long-Range Planning

The planning meeting's emphasis today was on transitioning Mars operations to a routine, without the constant changes that make things complicated and, hence, make things go wrong. The problems with the spacecraft over the weekend were all errors on our end, not spacecraft problems—the deep space network is just not well suited to what they call "joysticking around." They want a plan in advance, no last-minute changes, no surprises.

The idea of transitioning to a routine is a good one, but I'm afraid that routine may not include any of my sequences. So far, not one of my IMP sequences have been run. It just takes so long to get something into the plan—twice I'd thought I had sequences in the queue, but they got bumped for something with a higher priority.

There is still a ton of stuff to do here, but I have to get back home.

I'll have one day home in Cleveland, then I'll be at a reunion for the weekend, and then I have to fly to Houston to attend a review of another project, Mars 2001. It will be more than a week before I can get back here to Pasadena!

The good news is that it looks like my all-sky survey is finally on the schedule. The bad news is that it will run while I'm gone.

July 29: In the Doghouse

Right at the moment I am in the doghouse. Not literally, of course—I don't have a dog—actually I am in Houston. But one of my sequences has accidentally targeted the sun, and the engineers in charge of the camera are righteously annoyed.

After two weeks of postponements, the sequence ran at last on Saturday. It wasn't until the following Monday that I found out how much hot water I was in.

One of the constraints on camera operation—the flight rules—is that you can't point the camera directly at the sun. The camera lens is essentially a magnifying glass, and you sure don't want to concentrate sunlight directly on the sensitive CCD array that forms the retina of the camera.

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I was aware of this rule, of course, and as part of my sequence writing I had carefully calculated the position of the sun so that the sun would be just outside the edge of the frame. In fact, the last thing I had done when they told me that my camera sequence would be uplinked to run was to quickly recalculate the position of the sun to account for the two weeks of delay since I'd originally calculated the pointing.

After that I got on an airplane and flew back to Cleveland, to prepare for a meeting for a different project, Mars 2001.

Somewhere, though, there had been an error, and it sure looked like it was mine. Two of the images in my sky-survey sequence had pointed right at the sun.

Not good.

Fortunately, as the curt e-mail message I received continued on to tell me, the IMP camera was okay. I didn't melt it. The camera still had the filter, which cut down the light intensity on the CCD array even if it had not been intended for direct solar viewing. Also, the main lens of the camera is only a few millimeters across, making a rather small magnifying glass, and the automatic exposure control turned off the shutter before the sensitive CCD retina overheated. In other words, the safety factors on the camera had saved it.

Still, the whole purpose of flight rules is that you aren't *supposed* to rely on the safety factors; you're supposed to stay away from situations where the safety factors are all that stands between you and the destruction of the camera. If the safety factors hadn't saved me, I would have had to change my name and move to Montana. Not quite the kind of reputation I wanted!

July 30: Errors in Calculation

I lost quite a bit of sleep over the fact that the sun had been on-frame in not just one, but two of the frames. I could believe that just maybe I could have miscalculated the direction of the sun badly enough that it would be in one camera frame, but how could I possibly have made an error bad enough to actually do it twice?

After a lot of tossing and turning, it suddenly occurred to me that I was using both eyes of the camera, and if the sun was on-frame in one shot, of course it would be on frame in the other. With that, I remembered several working group meetings where other scientists had been complaining about the camera pointing—the pictures that the camera took weren't always exactly in the direction the camera had been commanded to point. Shots aimed at the Martian moons showed only black sky; shots of the sunrise that pointed west instead of east, shots of rocks that imaged sand and shots of the rover that imaged rocks. So, I told myself, the problem probably hadn't been in my calculations after all—the camera itself was bad.

Not that this really excused me, since I should have known that if the camera pointing was wobbly, I shouldn't have pointed the camera anywhere near *the sun. But at least it wasn't* only *my fault.*

That allowed me to get a good night's sleep, at least until the next day, when I phoned out to JPL and discovered that no, the sun hadn't been toward the edge of the frame; I had nailed it, right in the center of the picture. No way it could be explained away as a minor pointing problem: it was a direct hit.

But where could I have gone wrong? Had my last-minute calculation of the movement of the sun been wrong? That seemed to be the most likely error. After some hours of thinking about it, though, I eventually found where I had made the error. I hadn't merely been off by a few degrees, I had made a mirror-image inversion. I'd got the sun in the right position, all right—but in the exact opposite *hemisphere* of where it really had been.

(The moral—always get somebody *else* to check your calculations!)

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Makes me feel completely stupid, but oddly enough, there is an unexpected bonus to the miscalculation. It turns out that looking at the narrow disk of light surrounding the sun—known as the "solar aureole"—is the best way to get information about the size distribution of the very smallest dust particles in the atmosphere. And, of course, none of the scientists has dared to point the camera close enough to the sun to get a good measurement of the aureole. So, oddly, my blunder may have resulted in a measurement that could be a valuable one for studying dust.

It's a cheering thought. Maybe I'm not as much in the doghouse as I might have been. And I still have four more colors to measure. Maybe, just maybe, I might be able to get my sequences run to measure the other colors.

Or maybe not. It's a long way from the doghouse to the science working area, and I expect it'll be a cold day on Mars before they let me point the camera again.

But then, today's weather on Mars rose to a daytime high of fifteen below freezing, at high noon. Maybe it won't be that long after all!

August 5: Return to Pasadena

A week later, my meeting in Houston finished, I get back out to JPL and finally have a chance to view my images.

Back in Pasadena after only a week away, and it seems I've been spending all my time all day for two days just catching up. The spacecraft is now shutting down most nights, conserving batteries by only operating when solar power is available.

If one more person tells me "Hey, nice shot of the sun," I think I'm going to kill somebody.

I find that my sun images were not all that great: the sun is smeared, and one of the two colors overexposed. An undocumented quirk of the camera is that for the filter pair that I chose, the autoexpose function doesn't work. Autoexpose uses the left eye to set the exposure, and every single frame taken by the right eye was washed out.

I'm not the first or the tenth to mispoint the IMP; the chat today was about another mispointing, a scientist who tried to get an image of the star Arcturus, but programmed the sequence to run before Arcturus rose. The IMP, obedient to the request, pointed the camera in the right direction even though Mars was in the way. Of course, miscalculating the position of a star is less critical than miscalculating the position of the sun.

Turns out, later, that all of the camera pointing seems to be off, not just mine. The position of the lander is apparently off, there is something like a two degree offset.

And I did get a new IMP sequence in the queue, that sequence to look for a halo around the sun. Morning clouds have now been imaged by Pathfinder, but there is some controversy about whether it is low-level ice crystals, or high-altitude carbon dioxide. Viewing a halo would prove it is ice. And, of course, it would be pretty.

Only one thing: the sequence does have to run in the daytime.

Nick Thomas—head of the atmospheric imaging working group—comes to me, holding my new IMP sequence, and after politely asking how I calculated the position of the sun, mentions, oh, yes, by the way, I don't mind if he will be having somebody else verify the position of the sun?

Guess I deserve that.

August 6

No data today; the rover had an error on the traverse and dumped my MAE sequence. A pity, since this was a test to look at the effect of opening time, and try to figure out what's jamming the opening mechanism. No uplink tomorrow, so the earliest we can try again is Friday.

The spacecraft is now shutting down most nights, and so the idea of doing a halo search at sunrise has to wait.

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Today was an all-day meeting; Interesting to see what the other teams have found. The meteorological team saw a dust devil! Or, at least a cyclonic thermal—wind shift of 180 degrees as it passed over the lander, and a big pressure drop.

Rover team was wondering if their clock was OK. Howard asked me to check the solar cell data and see if the 9 A.M. solar cell measurement looked like 9 A.M. I checked it, and the light was awfully dim for 9 A.M.—from the brightness, I put it more like 7 A.M. Howard said, yep, that fits.

August 9

Noon MAE got skipped today, a rover error. We got a 2 P.M. measurement, and it showed lots of dust—14% coverage! Could it be from the dust devil? Or more likely just scatter in the data.

Halo search got discarded—Pete Smith says we have enough data from other sky images. I think we need to look closer to sunrise, but for the moment, the experiment is off the queue.

August 10: Back in Cleveland

Back in Cleveland. Work hasn't stopped because I've been out in Pasadena with Pathfinder; it's been piling up, and it may be weeks before I'm not buried.

I came in to the house this evening, and as I was opening the door, the kid next door and his friend come up, and park their bikes next to my car. "Say, tell me if it's true. Did you really name a rock on Mars?"

"Sure," I say.

"Cool!" He turns to his friend. "See? I told you so!"

September 4: Off-nominal

The battery on the rover died three days ago. It died without warning; we had hoped for maybe as much as another month of battery operation. Now the rover operation continues, but we can only operate during the daytime, when there's sun on the solar panels.

This kills off the experiments I had in the queue for night operations.

No data from the rover at all yesterday. Turns out that an unusual set of problems occurred, associated with the batteries.

At the end of Sol 58, the rover was executing a wait command, which turned communications off to run APXS measurements on a rock. While it waited, the sun got low in the sky. Without batteries to supplement the solar panels, with the low sun angle the voltage of the power system dropped. The APXS, trying to keep the power constant, drew increased current, and tripped an error condition. So the rover shut down.

Next morning the rover woke up at sunrise, when the power got high enough to run. First thing it did was to try to synchronize its clock with the lander, to find out what time it was—but it was too early, and the lander wasn't turned on yet, so this failed. Therefore, it assumed that it must still be Sol 58, and went on continuing what it was doing: run the "wait" command, with telemetry off. When the rover thought it was 15:30 local time (still thinking it was Sol 58), it turned off the APXS, and re-established communication with the lander. Then it did the next command in the sequence for the previous day—which was the end of day shutdown. So it went to sleep again!

It took two days for the rover team to figure out what was happening here, and load a new set of commands which wouldn't trip the rover into an error condition when the power was low. Some days things don't work as planned!

September 28

No data from the spacecraft again; people starting to worry.

Theory is that the lander battery died over night, and it's drawing the electrical bus down.

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(We didn't know it yet, but Pathfinder was dead.)

October 12

Still nothing.

The best theory seems to be that, with the main battery dead, the crystal in the unheated thermal enclosure is drifting.

Even with the battery dead, the spacecraft should be waking up on solar power. But drifting frequency could mean that the frequency the spacecraft is transmitting, and the one it is listening on, could be different than the ones we're sending and receiving from Earth. That, and the drifting on-board clock, makes it hard to know where and when to look for a signal. They're sweeping the signal frequency. On two days they received carrier, but haven't gotten a confirmation that the spacecraft received commands. They haven't been able to find the signal again.

As it turns out, they never did. The actual reason that the spacecraft stopped communicating remains a mystery.

November 5: Coda

The final project science group meeting. The project is officially over.

"Yesterday was officially our last hurrah, we all have tears in our beards," says Matt.

38 people in the meeting—a considerable drop from the 80 at the July 3 meeting.

At Ares Valles, summer is turning toward fall, and the days are getting shorter and cooler. The mission had been designed for thirty days. It lasted over eighty, so the mission was a success, with far more data than we had any chance to expect. Perhaps it will wake up again in the Martian spring, when the days get longer again—but nobody will take bets.

"We come to praise Pathfinder, not to bury her," says Matt.

"We're going to declare victory and move on," says Brian Muirhead.

Rover Sojourner was officially made a fellow of the Geological Society of America.

The meeting was not sad—I've never seen a meeting so raucous. No assumption went unchallenged, no interpretation unargued. Were the high silicon rock contents real, or was it a calibration artifact? Was Mermaid dune sand, and if not, was there any evidence of sand? Were the rocks imaged by Sojourner really conglomerates, or were they igneous rocks masquerading as conglomerates? Raw data with no consensus; bare-knuckled science at its best.

I am back working on other experiments now. My experiment on the 2001 Mars lander will be even more elaborate—if it's not canceled by a budget cut—and will not only look at the rate of dust accumulation, it will have a microscope to examine individual dust particles in detail. It's only four years to launch—time to get working!

The public is already beginning to forget Pathfinder. I will never forget, of course; fifty years from now, a hundred years from now, should I live that long, I will remind myself, I was part of it. I was there. I was at work in the science control area when Pathfinder landed. I might, if I'm lucky, be a part of a dozen other missions, but this one is special.

How could you ever forget the first time you touched Mars?■

People who don't have nightmares don't have dreams.

— Robert Paul Smith

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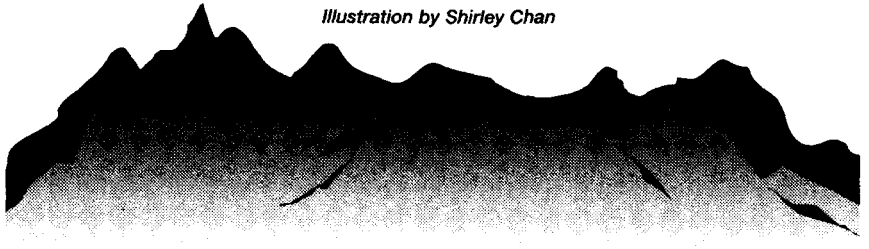
Probability Zero

EFFACING THE TRUTH

Arlan Andrews

Illustration by Shirley Chan



At 3 A.M. on The Day We Found Out, the President's Science Advisor entered the Oval Office of the White House, rubbing eyes tired with stress and worry. He carried with him a dozen videopapers, on which were the moving images that would change history. The Chief Executive was sitting at his desk in pajamas, eagerly scrutinizing the desk displate's closeup 3-D pictures of The Face On Mars. The Science Advisor was not surprised; almost every human being on Earth was doing exactly the same thing, from gulf to gulf, pole to pole. *But none in orbit*, he mused. *But that just might change after today.* Or would it?

The President glanced up at his old friend and grinned. "Just look at this, Al! The UNASA robots are sending back their pictures from the surface in Cydonia, and guess what? It really is a Face! We've finally found a piece of sculpture on another planet! Evidence of alien life! Not just fossilized bacteria, but real life!" The Science Advisor had never seen his boss so excited, not even after the Chinese break-up. "Just think of it, aliens on other planets, just like we always dreamed. And thank God, Al," the voice went to a whisper, "they're humans, or at least humanoid. We won't have to worry about having to be friendly with space spiders or giant centipedes, now will we? Just think, we can have friends Out There."

Pursing his lips, the Leader of His Nation fell silent. "Or maybe we *had* relatives out there, maybe millions of years in the past, probably, don't you think? Maybe we're even related somehow, you know? Like, it could be an ancient space colony, some kind of von Daniken thing?" As his boss sipped a cup of coffee, the Science Advisor stood silently, not responding, unblinking and sober. Still the President bubbled over with enthusiasm.

"This is really, really great!" the pajamaed man continued but, sensing no joy in his visitor, quickly let his voice taper off. As the grim visage of the elderly

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Science Advisor grew ever more somber, the President reined in all his boyish ebullience, pushed back his chair, rose and walked slowly around his desk to face the tall, goateed man. "Al," he whispered, "what in the *hell* is wrong? Isn't this what you wanted? To find life in outer space? To jumpstart the space program again after all these years? Hell, people got all excited years ago about microscopic *fossils*, for God's sake! With this kind of discovery, why, Congress and the Unies will throw all *kinds* of money to send *people* up there, to follow the robots."

Not to mention cinching your own place in history? the scientist thought. *Or will it?* Who knows what is going to happen when this comes out? Aloud he replied, handing over the sheaf of videopapers. "Mr. President. We have been holding back these highest-resolution, close-up pictures from the public, until UNASA scientists analyzed and verified them."

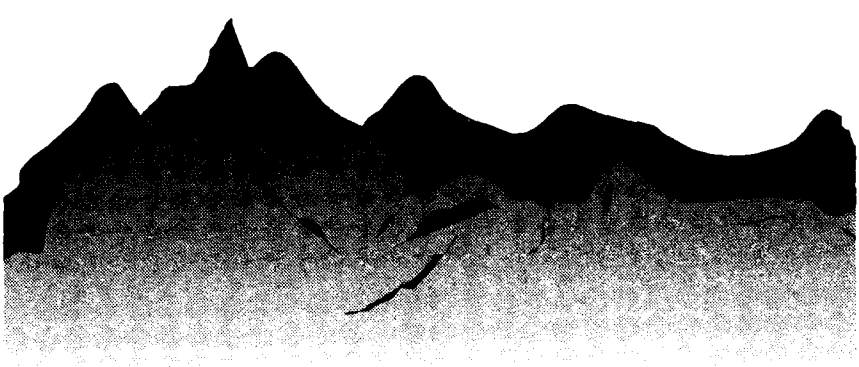
The President took the papers, each sheet of which was displaying its recorded ten-second 3-D video segment over and over. "Why hold them back, Al? These are the best yet, they're so good—" he tossed them onto his desktop one at a time, their images revealing ever more detail of the mountain-sized Face rising from the ancient sands of Mars as the robots from Earth grew ever closer. The armada of wheeled robots was approaching The Face from several directions, each camera yielding unique viewpoints from which to appreciate the manifold wonders of the Enigma.

"Al, these vids are so good that I can see incredible, really unbelievable features. Why—" As the last of the videopapers ran through its recorded motions, The President dropped his jaw; his hand was shaking as he thrust the flimsy sheet toward the Science Advisor, as if to cast it away.

"Yes, David, your impressions are correct," the older man said, nodding as he poked a finger into the image. The Science Advisor shook his head. "David, these closeup Mars Rover photos show more detail than we had imagined, more things than we had thought would even be there. They have produced all kinds of data from their arrays of depth-scanning instruments and of course, these visuals. Some of our little machines have even gone inside. As you surmised, it is hollow.

"We now know a lot more than we ever did before, and at last there is no avoiding reality. We know what The Face is. Really." He allowed himself a faint smile, but the President did catch the significance. "The Face On Mars, all one-mile length of it, is *not* a sculptured mountain, *not* a carving. It is hollow, but it is *not* a building, either.

"It's a skull!"■



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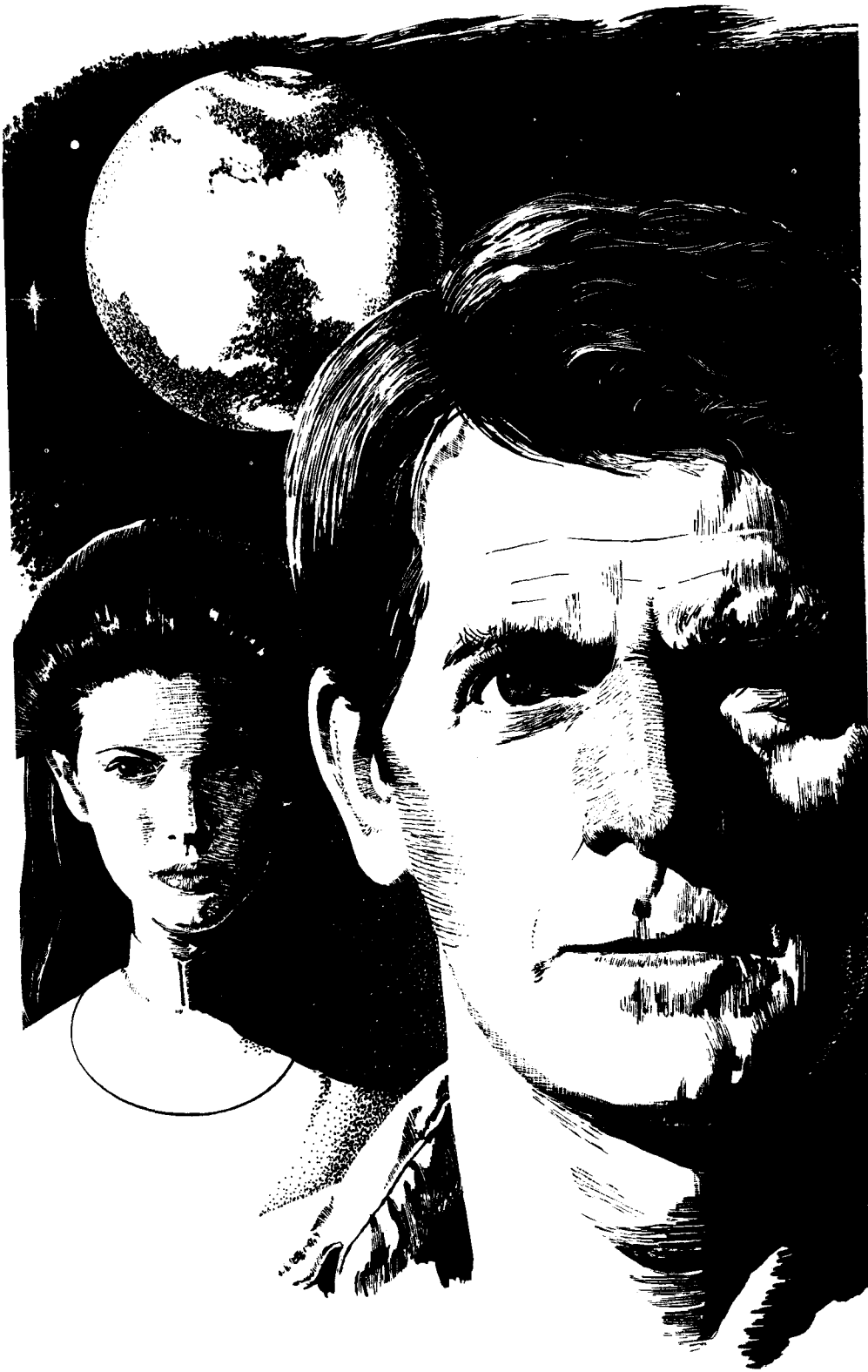

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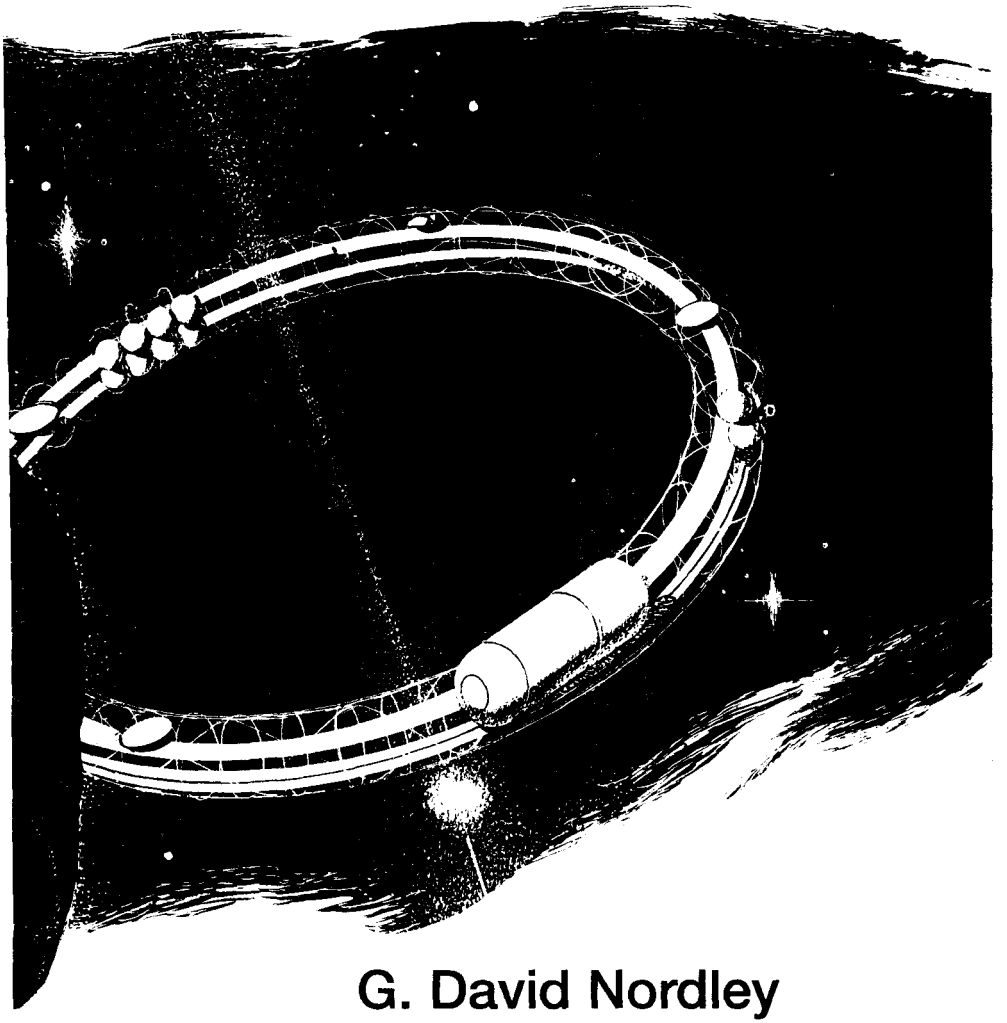

G. David Nordley

A LIFE ON MARS

Textbook problems in both life and technology tend to be neat and straightforward. Reality is a bit more complicated. . . .

Illustration by Vincent Di Fate

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"Pete, there's a priority message from Jovis Tholus University Hospital, your personal code. A Dr. Baklinova." There was a hint of urgency in Waldo's otherwise calm, somewhat Hitchcockian voice—a slight increase in pace, perhaps more emphasis on the higher harmonics? Whatever it was, the programmer's magic worked; I could sense the tension the computer personality tried to convey.

"Hold it for a moment." There was only one person on Mars that this call could be about, and I wasn't ready to deal with it cold. My ex, Jeanette, had left us for Mars back in 2046—literally without saying good-bye until she was on the transport. Then, April and I were so much surplus baggage. Now, apparently, she was in some kind of medical trouble.

I looked out the window. It was almost eight in the evening, universal time, and there were only a few lights on the eastern wall of the South Trench, reflected in the swimmer-rippled waters of the Central Park lake. Mars sat maybe ten degrees over the eastern wall, easily bright enough to see through the moonglass of the arched trench roof despite my office lights. The red planet was approaching opposition, just over sixty million kilometers away—about as near as anything major gets to anything else in the Solar System. But an eternity away in my personal life.

My desk sat in front of me filled with papers, real ones scattered over the virtual ones in the desktop screen. Work to me, life itself to my students. Sorry, kids, something's come up. . . . "Put it on the north wall screen," I told Waldo.

I tried to do something with a student's asteroid habitat design while light crawled to Mars and back. About nine minutes later, the view of Earth faded to white and my caller faded in.

Dr. Baklinova was nowhere to be seen. It was Jeanette. I didn't recognize her at first; she was in some kind of hospital bed, her head was immobilized, shaved, and there was a bandage over her right eye. Her face was bruised, mottled black, blue and yellow. The rest of her was covered.

"Hello, Pete." Her voice was not much more than a whisper. "Pete, there was a quake and a cave-in and I got hurt pretty bad. Among other things, I need a lung. They tell me I can't tolerate the stuff they use to make non-matching transplants, and I won't last long enough to grow a new one.

"But April is a tissue match; one of her lungs would work. Sorry to be so direct. Not much strength. Not much time. They're going to try to keep me going until you get here. Please." She opened her mouth as if to say something more, then closed it.

The view switched to an office with a sturdy woman in a blue shirt sitting behind a desk.

"Hello, Mr. Nelson, I'm Dr. Lada Baklinova at Jovis Tholis University Hospital." Russian, I thought, from the name and the accent. "Your wife . . ."

"I'm not married to her any more," I said automatically, then remembered the time lag. Sixty-four million kilometers away, a little over two hundred seconds at three hundred-thousand kilometers per second. Three and a half minutes, say. The correction would likely arrive after Baklinova had signed off.

". . . And insisted on making the appeal herself. You are probably wondering why we can't do a transplant from someone here. Your wife, unfortunately, is among the two or three percent of the population who have a strong toxic reaction to the drugs we need for that. There are facilities on Earth that might be able to handle the reaction, but here it would be fatal. We do not have any donors close enough to do it without those drugs. But your daughter, April, would be a match.

"However, the odds of Mrs. Nelson surviving on full life support until a donor arrives are not very good. Even at

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a reduced metabolic rate, there's about an even chance that she will die in seventy hours, maybe one chance in ten of surviving a week. Less than one in a hundred of surviving long enough for the next scheduled space transport. We will not give up, of course, and if you decide to come, we will do what we can to increase those odds, but it would be a big surprise if she lasted. I am very sorry about your wife but I thought it would be best if you know the truth. Baklinova Out."

"She's not my wife!" I yelled.

"Pete . . . ?" Waldo asked.

Waldo has standing orders to put any emotional outbursts on my part on ten-second delay.

"Right, Waldo, don't send that."

"The sentence 'She's not my wife,' has been deleted."

The view switched back to Jeanette.

We were near opposition—Mars, Earth, and Sun nearly lined up. A Monarch-class ion liner could get there in six weeks and an IPA cutter could . . . I didn't know what the current record was.

Please begin your response appeared along the bottom of the now-frozen screen.

Not yet. I had to think.

Memories. She'd been a bright young woman when we married, a few years younger than me, with long straight brown hair and a sharp, almost elfin kind of face. I'd kept her picture on my desk, maybe longer than I should have.

Moonlit walks on campus. Riverbanking. Learning about love together. Coping with a child and careers that kept each of us traveling. Her ultimatum that led to my quitting the engineering corps and joining the University faculty. Setting up the household at Coriolis Crater. April's first day at school in the last quarter of 2045. Seven years ago, but some days it seemed like we'd just gotten here.

* * *

The time delay between planets encourages a certain lack of concentration—I'd been musing for two minutes. Back to the present, Pete—time to say something. What? *Gee that's too bad, we had some nice times. I'll have April send a get well message.*

I owed that woman nothing anymore. Nothing.

But there was a challenge in this and my mind had already started making calculations. My friend and colleague, Ahmed Fahsi, ran the spaceflight research station at Martinez Crater and was also its chief engineer—the Cislunar Republic's version of Sergei Korolev, Werner Von Braun, or Kelly Johnson. His beamriders hadn't been well received in the traditional, self-contained spacecraft world, and he was looking for publicity. But he had completed one ship—the *Edmund Halley*—that had performed several spectacular missions, including a comet rendezvous.

It could do, what, three or four gravities? I could probably ignore solar gravity . . . allow ten million kilometers for acceleration and deceleration . . . cruise for fifty kiloseconds at one thousand km per second . . . forty kiloseconds at twenty-five meters per second . . . Jupiter gravity . . . survive that lying down . . . It might take a day and a half and Jeanette might last a couple of days on the machine . . . no, that was ridiculous. Or was it?

This would be a good excuse for Ahmed to show the Solar System what his stuff could do. He might go for it. He just might.

The engineer in me was at war with the abused ex-husband—and the engineer was winning. Something between twenty and forty hours might actually be possible.

The "Please begin your response" line started flashing. The doctor probably needed to put her to sleep, so she'll last longer. Other people need to use the circuits. I'd better say something.

"I'm really sorry you got hurt, Jeanette. This is pretty sudden, I haven't

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had a chance to think anything through. April's at school—drill team practice tonight—and . . ."

What if April said 'yes'? What would you do then, Pete, you idiot?

". . . You're a tough lady, so I think you have as good a chance as anyone to pull through this. Maybe there's something we can do. I'll send another message tonight with April. Uh . . . Peter Nelson out."

The screen cleared, replaced by the cool blue seas and swirling clouds of Earth again, but I couldn't see it. What I saw was a surgeon's laser plunging into my innocent daughter's chest.

"Waldo, check the medical data they dumped. Just how much lung capacity does Jeanette have left?"

The answer was immediate. "None."

What had that doctor said? Full life support? She'd meant it. "But how?"

"Pulmonary edema when her suit was breached," Waldo answered. "There was some function in the left lung for a day or so, but that's gone now. She's being maintained artificially. The heart's gone too, but that prosthesis is fairly standard, even on Mars. Lungs are much more difficult."

"No heart? No lungs? How long can she last?"

"They removed the dead tissue and started budding a new left lung in the chest cavity. But that will take several months to come on-line. The longevity record for being on combined heart-lung machines is about eight weeks, and that was achieved by someone who was in much better shape otherwise. A high rate of micro-clotting due to the enormous exposure to foreign material and capillary fouling are the main problems. This case yields a fifty percent survival time of fifty-eight hours, with a decline to one percent at 311 hours."

"Got it." Pretty much the same numbers the doctor had. "Why do they need a tissue match? Can't they just reprogram the immune system or something?"

"Do you want the long or the short answer?"

I'd taught Waldo to ask that. One gets busy at times.

"The short one for now."

"They would need to reprogram every cell in the donor organ or in the recipient body. They aren't there yet."

I thought furiously. To delay anything would be tantamount to a decision not to help, and I wasn't ready to decide that yet. I had to proceed as if April was going to donate and we were going to Mars. If we weren't—well, that was the decision I could make at the last moment. I was just preserving my options, that's all. Jeanette got herself into that mess and just maybe she would have to pay the price instead of cutting up our kid to get out of it.

Jeanette. For better or worse, by some primordial law of imprinting, I still felt responsible for her. But the decision was not mine. I could not tell April to do this. But I would ask.

I didn't want this. I really didn't.

Memories came flooding back again.

For some reason, I'd said yes to a consulting job in Kurdistan in 2046. We'd fabricated a dam liner on the Moon to help the Kurds control a river without destroying its flood plain. It weighed thirty thousand tons and with a terminal velocity of fifty meters per second, it had to fall in exactly the right place, its impact cushioned by thirteen hundred computer controlled CO jets. Then we finished molding it to the terrain with a cloud of superheated steam. We were a little behind schedule but perfect execution was worth the delay. I'd been focused on that to the exclusion of everything else for three months and felt ready to celebrate the achievement.

But in a matter of hours, my elation became loss and despair. They'd found the microbe colonies in the roots of Olympus Mons and there was a transport due out that week. Jeanette left April with her sister and got on it; planets

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don't wait. She actually called me from the ship, outbound—*fait accompli*.

Then there was the dragging out of it all. There'd been nothing final in her departure message, and she'd left April and many personal things as if she'd intended to return some day. It was the months of uncertainty that had hurt as much as anything else.

Messages went back and forth every day for a while. Then every week. There was a ship scheduled to leave Mars six months after she arrived. Would she be done by then? Maybe. Another ship six weeks later. She promised to be on that one, but changed her mind. I got that message after it had left Phobos. Was I still married? What was going on? The calls came every week, then every month, then a year.

I remembered very clearly the last time I'd said "I love you" to her—I'd been crying then, too. That had been five years ago. Kids are more adaptable; April Jeanne had stopped asking "When is Mommy coming home?" long before that.

Tamika had moved in with us a year or so after that—no contract, no guarantees; she had just emigrated from Hawaii and latched onto us like one atom of hydrogen latches onto another in need of a complete electron shell. Some semblance of a family had began to form again.

The official divorce had been in forty-eight, with Jeanette's signature faxed from three kilometers underground somewhere in Tharsis; she'd been interviewed there on that Astrographic special about the microworms, apparently unaffected by anything in her personal life.

Then, three years ago, Jeanette began talking about bringing April to Mars. I'd said no and things had gotten testy.

"Waldo, would you explain the situation to the school officials? I'll be there to talk to April in about ten minutes. And see if you can find Ahmed Fahsi and have him call me on the way."

I looked out at my balcony—as an assistant professor, I'd earned an inner office only three stories up, and in the old days, I would have jumped to the sidewalk below without a second thought. But a month ago some idiot Earth tourist kid had broken a leg and injured a pedestrian trying that without knowing how—and the muni council, in a fit of paternalism, had forbidden jumping to the street from the third floor up. So I had to take the interior pole, about ten doors north of my office.

My mind clamped onto ordinary things like a vise, as if to keep itself off the upcoming conversation with April: the smoothness of the pole on my hand as I braked my descent; the smell of the giant roses along the path to the school.

As I passed the athletic clearing, a moonball bounced in front of me—I grabbed it automatically and threw it back up at a young man gliding back to the turf on a slow lunar trajectory, his bare skin glistening with sweat and eyes bright with excitement. He was immediately tackled by an equally bare girl and the ball went flying away into a knot of youngsters.

How bad a scar would the operation leave on April? They wanted a lung. It would be a huge incision; it would have to be. What kind of sacrifice was I asking her to make—having scars on the chest is OK for guys, a macho thing. But for girls, it could be a disfigurement. . . . She was just beginning to develop and deathly proud of it. No, I was back in my childhood again; they could fix a surgical scar now, generate fresh skin. In a few months she wouldn't be able to find it.

"Pete, Ahmed." His voice came in on my earpiece. I didn't look at my wrist for a picture—I knew what Ahmed looked like—an almost two meter bear of a man, bald as a cue ball, sporting the gentle brown tan he was born with. "I got your message about Jeanette. I have bad news, I'm afraid."

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I stumbled and almost did a flip, then had to rotate my arms wildly to get a foot down for the next stride. "Ahmed, Pete. Let's have it."

"The *Edmund Halley* left for Ceres thirteen hours ago. She hasn't finished acceleration, but I can't get her back. You know how it works."

I knew. Ahmed's ships have to be pushed by a mass beam—their main engines stay on the moon, and wait for them at their destination. That's why they can go so fast; they don't have to carry their reaction mass. But it also means a certain lack of flexibility.

"Damn! Any idea of what the Coriolis launch track could give an IPA ship, with a full load for post launch acceleration?" The Interplanetary Authority had the fastest high-g ships in the Solar System, next to the *Edmund Halley*.

I had a mental picture of Ahmed shrugging his shoulders. "A hydrogen nuclear-thermal IPA cutter can fly with a mass ratio of twenty—that means they can do about three times their exhaust velocity, and their exhaust velocity is-about eleven kilometers per second—now add six for the maximum launch track boost and you should get maybe thirty-six kilometers per second total delta vee? Eighteen up, eighteen down. But it is not pointed the right direction. If you wait for the Moon to come around in two weeks, you do not get there much sooner than an ion liner anyway."

That should have been just fine. I didn't really want to go anyway. Options closed, no guilt, OK?

Not OK.

"Ahmed, you've got some other things in work, don't you, and some experimental stuff from before the *Halley*?"

"May Allah be praised." It was Ahmed's habit to say this quickly and softly and it came out sounding something like "mahlabraced," the way someone born in a Christian culture might say "Geez." It was a relic of his past; we shared that—having previous lives. "Just what kind of risk are you willing to take?" he added.

"Not willing, just considering at this point. But if April says yes, that would mean she's willing to undergo a major operation and live on one lung for a while. So I'm willing to consider risk on that level. What are the options?"

Silence.

"Ahmed?"

"You have posed an interesting problem. Come over here, ready to go immediately, and I will explain your options then."

"How . . . ?"

"I do not know fully myself, yet. But where there is such a will, surely a way can be found. I will tell you now that I have two fully functional reflector rings in the yard, but without very much ship around either of them. What I can do with them I cannot say yet. But time is very short, so you make your preparations and come as if I already have an answer, all right?"

"Bless you Ahmed, I haven't asked April yet. She'll likely say 'no way.'"

"April is a remarkable young woman, Pete. She visits my field several times with her classmates, and I think she has more . . . I do not know the word . . . more *jets* in her than all of them. True, she may say no. But I will wait for you nevertheless. Good luck and out."

My legs were on autopilot, and as my talk with Ahmed finished, I arrived in a playground full of laughing children in blue jumpsuits, milling around in no detectable order. The South Trench Bluebirds, I recalled, whose practice must be over. April was a raven-haired pixie with double pigtails and a white shell necklace—lunar snail shells left by lunar snails from the Central Parks that had moved onto bigger and better things—escargot at Duluth's restaurant, for instance. April collected them for Marie Duluth, and got to keep the shells in payment. I scanned the kids.

But I recognized Tamika's willowy figure first, next to a tall birch silhouetted

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in the school's soft yard light and then April next to her. Complications. I owed Tamika whatever emotional stability I'd gained in the last five years and now I was proposing to go to Mars to save her predecessor. How would she react to that?

Jeanette might ask us to stay. I had a daughter with her and so much history together . . . it had been my greatest wish that everything that had happened could go away and I could have my family back again. Hope had died hard; Tamika knew that.

I loped toward them with ten-meter strides and caught the trunk of the birch with my left hand to help bring myself to a dignified halt.

Tamika's Eurasian features were calm but serious as she urged April toward me. April leaped the last few meters between us, into my arms.

"Tammy told me Mom's hurt bad!"

I looked at Tamika.

"I called Waldo," she said. "I haven't told her everything."

"Yes," I said. I hadn't thought of telling him not to tell her. This was going to be tough on her, I thought, and unavoidable now. "Let's sit down somewhere."

There was a bench near the school entrance, an ordinary gray sintered moondust bench, with kids' initials carved in it. The other kids were melting away, leaving us alone.

Where to start? "April, your mother got hurt in a cave-in and needs a lung transplant within a few days if she is going to live."

"She might die? You want to say goodbye before she has the operation?"

I shook my head. "They don't have any appropriate donors on Mars, or anywhere nearby. Your blood and tissue are the right type—they want you to be the donor."

"Me?" Her eyes went wide and her mouth formed a huge "O" as the implications set in. April had perfect teeth. I tried to remember the last time we'd stuck a dental examiner in her mouth—should do that every month, but things get busy—if it came to a custody fight, would that count against me? April was staring at me; there'd been a question mark at the end of that "Me?"

"You." I said.

"But we're here and Mars is there!" April looked up in the sky in the right direction, bless her, and, in a blink, pointed to the right bright red star. I had to smile. What a kid!

"Ahmed might be able to get us there in time."

It was Tamika's turn to get wide-eyed. "This is possible?"

"He's not sure, but he didn't say 'no' right away. If April says yes, we're to pack and get over there right away. Mars is setting, and it has to be above the horizon for his thing to work."

"You still love Mom a little, don't you, Dad?" April asked.

"April, there are still some things that you're a little too young—"

"Nuts. I'll bet you don't even know that I know why my name is April when I was born in January?"

"April!"

Tamika giggled.

"Look," I said. "You can't be that close to someone and not have feelings, whatever they are. But my feelings aren't so important now—it's your lung. The question is, are you willing to donate a lung to save someone's life?"

April looked down at her chest, then drew a line with her finger from her collar bone down over her right breast to the bottom of her rib cage. Her fingernail left a thin crease in the blue fabric. She looked up at me, scared. "Either that or Mom dies, huh?"

I shut my eyes. No. Yes. "April, I don't know how they do operations like that but they can probably repair anything they do in a couple of months or so."

Tamika put a hand on my shoulder. "I think what they used to do is to split the breast bone, not the breast, then pull the rib cage back, and take it out that

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way. But now, I think they can go in under the rib cage, through the diaphragm, with all sorts of special tools. Still, for a lung, I think it would have to be a big incision."

April looked at her, then back at her chest and drew another line below her rib cage. Then she looked at Tamika again.

"Will it hurt?"

"Yes," Tamika said, "but not until after the operation. They'll put you to sleep for the operation itself. They will have pills to help you endure the pain afterward."

It dawned on me that Tamika was speaking in favor of saving the life of the woman who was still her rival in my affections, no matter how much I tried to deny it.

"Another ethics lesson?" April asked.

"Yes," Tamika said at once, answering both April's question and mine.

"What goes in there if they take the lung out?" April pointed to her chest.

Waldo found out. They use a degradable air jell bag that serves as a scaffold and then dissolves away as the new lung grows in its place.

April asked more questions and pretty soon we all had a good picture of what was involved. Finally, April nodded her head with an expression so serious that only children on the verge of adolescence can manage it.

"Cool. I can deal with it. Do I get to go to Mars? Or just my lung?"

Tamika smiled. "The less time a donated organ spends out of a body, the better."

"Can I keep the scar, Dad? That would be *really* gross. The kids would *stare*. They'd be vacuum boiled! Can I keep the scar, huh?"

People who think they understand kids should have one. I put an arm around mine and smiled.

"Look, there's no guarantee that we can get to Mars in time. But we have to play it as if we could, so we're going home to grab a change of clothes and an overnight kit. Everything else we need we'll get when and if we get to Mars. Then we're going to Ahmed Fahsi's launch site and—"

"Beamriders! We're going to get to go on a beamrider!"

"Maybe, April. Maybe."

"Maybe, Pete."

We were in spacesuits with duffel bags on the spotless lunar concrete of the experimental rocket base. Mars hung red and brilliant about ten degrees above the west horizon, in Sagittarius. The Milky Way outlined the distant western ring wall.

"This is the *Korolev*, or it will be when we finish it. It looks a bit, how would you say it, ramshackle now. But it is more than strong enough. Stronger, really, without all the pretty stuff."

"This" looked something like an oversized lunar wire-basket wheel without a hub. It was at least fifty meters from center to edge and lay on its side, held off the regolith by three man-sized posts. The lattice frame enclosed an incomplete ten-meter-long sausage-shaped cabin—the surface of this section was infested by spider-like robots going about various tasks. Cables and pipes ran around an open conduit on the outside perimeter of the ring, occasionally intersecting pairs of spherical tanks. The conduit terminated diametrically across from the cabin among some dark gray tanks with radiation warning symbols all over them. It looked very much like a work in progress.

"Is that really enough? What if there's a radiation storm?" The mass of a big liner and its life support system can come in handy at times.

"There is a solar storm in progress, as it happens, but the drives magnetic field will protect you from that. For a day or two of life support, you do not need the whole hull."

A day or two. The implications of setting a record like that started to sink in. It would be revolutionary and not everyone

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liked revolutions—especially unplanned revolutions.

Tamika and April skipped over to it in their vacuum suits, kicking up small sprays of dust as they went. I stayed back with Ahmed.

"We just brought her down from a ten-day hover test. She flies fine, Pete. The robots—they are making some final life support arrangements."

"Where's the door?" April asked, from the ship.

Ahmed's face was unreadable for the reflected stars, but one can do an adequate shrug in a vacuum suit. "There is not time for everything. One of the plates is removable from the inside if you depressurize first. You'll have vacuum tape to seal it from the inside."

No. There was no way I was going to go through with this. Not this way. "Ahmed . . ." I began to say no, but what I heard myself saying instead was, ". . . just in case we are crazy enough to do this, how long to Phobos?"

Ahmed waved a hand at an innocent-looking dome near the corner of the space port. "The mass accelerator could push a complete ship at three gravities. Like that," he gestured to the skeletal, partly finished ship. "It has so little mass, I could push you at up to five gravities."

Five gravities? I remembered my calculation. I couldn't concentrate well enough to do another one, but it seemed that five gravities would get us there in less than a day. This didn't seem real. Interplanetary journeys took months—well, weeks if you were really in a hurry. Five gravities . . . ?

"How far can you push us?" April asked. "Can you hit the ship with the beam all the way to Mars?"

"Aha!" Ahmed said, grinning. He produced a small transparent bag full of what looked to be dust, took a handful and tossed it high into the lunar night. "Watch this!" He pointed a small rod in the direction of the dust that emitted nothing that I could see. But the dust particles began to twinkle furiously as they fell, forming a fuzzy solid cylinder with its axis directed toward Ahmed's rod.

"*Fairy dust?*" April squealed. "You have fairy dust!?"

"Fairy dust if you like, little one. The particles I push the ship with are trying to push themselves toward the center of this ultraviolet beam with little flashes of light of their own. If I could give them more time, they would do so. With these, I can push you as far as I want—maybe to Alpha Centauri if I can shoot the particles fast enough! But you would have to slow down at the other end and I don't have a base there . . ." He grinned. ". . . yet. But Mars is no problem."

"Five Earth gravities is thirty times April's normal weight," Tamika said.

"How would I fly it?" I asked.

Ahmed raised a hand. "Oh, one at a time, please! Now—I can adjust the flotation beds I have on hand to fit your vacuum suits in a few minutes." He pointed toward some coffin-shaped objects. "Immersed at neutral buoyancy, you will not feel so much acceleration. Everything is ready; I only need to make a rough mold of your form so we do not use too much flotation oil and have so much extra mass that our acceleration is compromised. You cannot fly the ship—there are no manual controls yet. The computers will control everything—but do not worry, they are five times redundant."

I stared at the ramshackle ring of lattice, pipes, boxes, and cylinders. I did not need to take this chance. I didn't owe her anything. "This is looking a little like pushing the limit to me, Ahmed. I might risk it myself, but with a twelve-year-old—"

"Dad . . ."

Ahmed cleared his throat. "Cabin conditions will be very primitive, but it would only be for a few hours." He seemed to be trying to sell me on it. He'd known Jeanette, of course; the Moon was still a small place. Was he helping

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her as much as me? We never really know how others view a split up; maybe he thought it was my fault. Or maybe he . . . none of my business, really.

"I'm tight, Dad," April said. "I can handle it."

I looked at Tamika. She looked at me. Ahmed looked at his wrist comp.

"Compared to the value of the experience, the risk is small," Tamika said. "Not many people have the opportunity to do such a deed."

Over the last five years, I had come to rely on her for such judgments. My mind was numb.

I thought of being sealed in that thin-walled tomb. Risk. Speed. Experience. Letting go. I nodded. A life was at stake, one that I had tried to write out of my universe but here it came calling back like some kind of ghoul for the unfinished business that was our daughter. Should what I felt be the controlling consideration? Or was this fate pounding at the door?

There seemed nothing I could do but nod, and as I did my stomach became tight as a drum. It wasn't a well-reasoned decision. Maybe I would get away with it.

"Very well," said Ahmed "Allah be with you." He said that slowly, almost like a prayer.

The next hour was a blur that ended with April and me floating in our acceleration beds in the cabin of the skeletal spacecraft—a very functional-looking control room with racks of equipment, a rat's nest of cabling, and bare titanium lattice girders wherever there weren't screens. Ahmed had stuck standard one-meter screens every which way to the point that the hull looked mostly transparent. The one just over my feet showed Mars, sinking toward the lunar horizon. We would have to complete our acceleration before it came between us and Ahmed's drive projectors.

Incongruously, one screen overhead showed the *Korolev* on its pad as seen from Ahmed's control center at the edge of the field. It looked more ramshackle than ever.

Just inside the one true opening of our cabin, a stick-man robot under the *Korolev*'s control held a panel that would function as our "door." As a safety measure, we would wait until achieving lunar escape velocity before closing it and pressurizing the cabin. Our "coffins" sat on a floor bare except for a pair of trunks of life support gear. One would give us our air, the toilet was in the other. We could unpack that once the cabin was sealed.

"Are you ready, April?"

"Sure, Dad." There was tension in that voice. A hell of a lot of tension.

"Ready here, Ahmed."

"Raise the ship," Ahmed told his comp.

"The instruction has been countermanded," the soft, female voice of the control center's AI declared. "Port Captain Kelly wishes to speak with whoever is in charge of this flight."

Ahmed groaned. "This is my launch, Kelly."

"*Korolev*, put Kelly and Ahmed on the front screen, I said." Mars vanished.

Bart Kelly, a large muscular man with curly black hair, came on screen. I knew him from somewhere.

"We can't allow this, Ahmed."

"There are extraordinary circumstances, Bart. Any delay at all may cost a life."

"Which I understand may very well be lost anyway. I wouldn't want to lose other lives on the chance. Fahsi, this isn't the time or the way to be setting any Moon-Mars speed records. Give it up."

"What," Ahmed said between nearly clenched teeth, "do we have to do to satisfy you? The vehicle is spaceworthy—it has completed ten times the length of the journey in hover tests. I have enough redundancy for computer piloting."

Kelly smiled with teeth showing. "There are Cislunar Republic resources

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involved here and a judgment call to make which is not yours alone."

"Very well. What do we have to do?"

"Comply with the provisions of the Cislunar Space Navigation Protocol."

Ahmed looked like he was about to explode. I didn't know Kelly, but thought a diversion was in order. "Pete Nelson here. Captain Kelly, I thought we were in compliance. What is your objection?"

"I don't have time to go through the details, Mr. Nelson. My autosec can arrange an appointment with our legal staff."

I smelled a rat. A specific problem can be dealt with and this guy was doing everything he could not to specify—it seemed a delay tactic. Whose ax was Kelly grinding?

"We'll correct whatever might be wrong and file again."

"That's your privilege, but I just don't think it's going to work. In my humble opinion, this is just too risky. Kelly out."

Finally I placed the face. "Ahmed, I think Kelly used to fly L1 shuttles."

"Of course he did. And now he's stuck playing port captain waiting for a shift leader's berth on a deep space ion liner." Ahmed looked furious. "Spacetrans!—and they do not want to replace their ion rockets! And the space crews—you need three times as many people to run an ion rocket liner as one of my design; they don't want to see that number go down. I bet someone in Spacetrans promised him a berth if he keeps us here. This demonstration would be broadcast all over the Solar System—and they do not want to see that just yet! You may as well come back to the control center. We have—what?— maybe an hour to figure this out."

To get Ahmed to *really* do something, tell him it can't be done. April and I got up, clambered out of the *Korolev* and headed for the control center.

Ahmed, Tamika, and I each had a terminal and a section of the Protocol to study. Ahmed looked like he could take a scimitar to someone's neck. Tamika's slick little page cut generally didn't need maintenance—but now she combed it furiously with her hand. God knows what I looked like.

"Why don't we just go anyway?" April wanted to know. "You know, like civil disobedience."

Ahmed turned toward her, and waved a hand. "Even though I built it, this facility does not belong to me; I just get to run it. I must obey the law or someone else will take my work."

"Why won't the vac-boiled idiots let us go?"

"Because we are a threat to someone."

"But that's not ethical either, is it, Tamika?"

Tamika clapped her hands. "No, it's not, nor can it be legal. Look, guys, I think we're working the problem from the wrong end. Kelly may not have to give *us* a reason to bar our departure, but he certainly had to give one to the Port computer! Ahmed, can you find out what it was?"

He shook his head. "I do not have the authority . . ."

Authority. Jeanette's cousin, Tad Reynolds. I knew him only slightly, but he ran the Cislunar Republic's public service corps. He could probably care less about me now, but in this case . . .

"I know someone who does," I said.

It took Ahmed's AI a couple of minutes to find him and put him on. Tad had a boyish shock of light brown hair that made him look more thirty something than the fifty something I knew him to be. After I explained the situation, he pursed his lips, looked somewhere in his office, and did something I couldn't see with his hands.

"The human control provisions of Interplanetary Association Treaty," Tad said after a moment.

"But I'm a fully qualified pilot and April will be on board, too!" I was confused. Human control: a face-saving is-

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sue in the carefully negotiated détente between the United Nations of Earth and the Cislunar Republic thirty years ago—the people at the bottom of the Terrestrial gravity well wanted someone to blame if things fell on them, and the negotiators felt they had to allow some pretext of moral justification for the U.N.'s unsuccessful power play. Human control was a formality these days—everything smart enough to know it existed had human control burned into it.

"According to the rules, April does not qualify as a redundant human control."

"But kids her age fly all over the place."

Tad sighed. "A jet cycle's AI isn't smart enough to trigger the treaty provisions, Pete, and you're going beyond the one-light-minute treaty limit for back-up telecontrol. It's a technicality, I admit—April could certainly throw switches if something went wrong. But we honor technicalities."

"So I need another qualified pilot?"

A long pause, then, "Pete, Ahmed has gotten a little ahead of the power curve, as far as Spacetrans is concerned. Spacetrans is a Cislunar company, but the board still has an Earth majority. I don't think the P.M. wants to put vacuum in their hoses yet, even with a life at stake."

Our current prime minister was as tough with his own people as he was soft with Earth. That, everyone said, would change with the next election.

"Even Jeanette's?"

Tad shook his head. "Look, she's family, but she's burned family bridges, too, with her thoughtlessness. Do you still care that much?"

I didn't answer. I wasn't sure how well Tad could read my face through a space helmet visor from a wrist comp cam, but I just stared at it. Yes I did care, no I didn't. Go figure it out.

Whatever passed on that staring channel passed. Tad cleared his throat. "Listen carefully, Pete. We have to deal with political realities. *Listen carefully.* I think I've given you enough information. More than some people would want me to give out. I've got to call it a conversation, now. Good luck. Reynolds out."

Listen carefully? It just occurred to me that someone else might be listening too.

Honor technicalities? The AI would. Good luck, he'd said. If I were up to grasping at straws, there may be straws to grasp. But if I wanted an excuse to walk away from it, well, I'd been given it. No one, not even Jeanette's family, would blame me. The whole damn thing was back on my shoulders.

"Hmm," Tamika said. "The protocol articles specify human control redundancy. Piloting redundancy is a Cislunar Republic requirement, which can be met by the AI. *They are not the same requirement.* As an adult with a degree in philosophy and a minor in logic, I could more than satisfy the human control redundancy requirement, and you and the *Korolev*'s computer would satisfy the piloting redundancy requirement. You don't have to have two qualified pilots."

Ahmed slapped a hand down on the desk in front of him. "They would call that evading the spirit of the law."

"But not the letter," Tamika said.

"Is it cheating?" April asked. "Ethically?"

Tamika frowned deeply. "No," she said at last. "It is uncomfortably close, but it balances what is uncomfortably close to misuse of law by the other side, I think. And there is the possibility of saving a life to tip the balance toward the greater good."

Left unsaid was the possibility of harm to her; the possibility of losing April, and possibly me—to an accident. Or her losing me to Jeanette if we succeeded. Could my little family be put back together again? Only three or four years ago, I would have asked nothing more of this universe. Could I resist an attempt by Jeanette to do so now, once we were on Mars?

"Ethically," Ahmed said. "I think Allah

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will forgive us for trying. And I think others will forgive us if we succeed. This is not a business for cowards. Jinn," he addressed his AI, "put another fluid bed on the *Korolev*, and compose a new flight plan with Tamika as cybernetics officer. Our move."

Ahmed had been the Lunar chess champion a few years ago, I recalled. He had moved quickly and the opponent had run out of time in the end game. But . . .

"No!" I said. "Ahmed, wait!"

Everyone stared at me.

"Jinn, hold that." Ahmed looked deflated. "But I do not blame you, friend."

"It's not that," I said. "We need to do what you were going to do. Kelly and his friends will attack the new flight plan with every argument they can think of. *If* we give them time to do so."

"Of course," Tamika said, "but . . . ?"

"Let's get everything ready, and then file the plan at the absolute last second. Ahmed, while it's being filed, call Kelly. He's probably got us flagged, but if he's busy, the human approval will go to a lieutenant. And file a return plan for our hopper at the same time."

A big grin split Ahmed's face. "And a hover test plan for one of my other spacecraft. While I am discussing his rules with him . . ." he laughed. "They will be saturated, and while these discussions go on . . ." he raised his flat hand up from the desk toward the ceiling. ". . . off you go!"

Half an hour later, off we went. The *Korolev* lifted itself gently on its auxiliary jets to about ten kilometers altitude and put itself between the beam projector and Mars. "Fairy dust" rose toward us, flashed into plasma, and we leapt Marsward. But I hardly noticed the acceleration because, on the screen above me, Kelly's face turned livid at the bull Ahmed was throwing at him.

I'll give Kelly credit: it had only taken him fifty seconds to catch onto what had happened. But in those fifty seconds we had reached lunar escape velocity.

"Emergency abort!" he thundered. "Override the experimental field's AI!"

We could hear the port AI respond over our link. "There is no emergency," it said. "However, interrupting a beam launch in progress would endanger the occupants, creating an emergency. The abort cannot be executed."

"I'm telling you on human authority that there is an emergency," Kelly tried.

Tamika giggled, and in a second I realized why. Kelly was trying to get a state-of-the-art exaflop cybernetic system with full access to all the information into an Asimovian logic loop. It had probably checked every possibility and modeled the psychology of its reply a dozen times before Kelly even finished speaking.

"The telemetry on the spacecraft shows no immediate danger. Could you please specify your reason for thinking there is one? Also, cutting the beam now would leave the spacecraft on a very inconvenient trajectory for rescue. Do you wish to take responsibility for a command override?"

Kelly opened his mouth, then shut it and stared. Finally, he said. "Fahsi, first *you* figure out a way to get them back while I call some *people*. Then, I'd get ready to clean out your desk. Kelly out."

"Having a clean desk is a good idea," Ahmed replied smoothly. "Perhaps at the end of the day we will see whose is most clean. Mine, or yours. Fahsi out."

Kelly's face vanished.

Ahmed's replaced it, and he looked worried. The "secure" superscript indication appeared on our screen. He glanced up to where he knew the notation would appear to us.

"They'll know we have a secret now, but I need to tell you this. We dodged one there; the trajectory is not that inconvenient for us to abort, but the port AI did not realize that because there are some things about this that even my AI does not know. But, if they think of it, the Deimos base projector can send a beam to push you back toward the

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Moon from almost any point between here and there.

"If you want to avoid that, you will have to quench your magnetic field, then bring it up again twenty gigameters out from Deimos. At that point, the only plausible abort will be to Deimos and they will be faced with a fait accompli. But while your field is quenched, you will be vulnerable to solar radiation storms, so let us hope you think of something else."

"*Us* think of something else?"

It was almost a second before Ahmed replied. Half a second of light-speed delay already!

"They will break into this supposedly secure link in seconds if they have not already done so, but they cannot break into your minds. Anticipate. Use the light-speed delay to act instead of react. Now, Allah be with you."

"Ahmed," Tamika said. "You have taken a great risk; rightly, I think. But what are you going to do?"

We waited a second and then saw a smile on Ahmed's face.

"I should not say everything. But for one thing, I will call a press conference. Ahmed out."

Act instead of react.

"Will they push us back with the fairy dust?" April asked.

"It's possible. It depends on who's in charge of what, I guess."

She sighed. "Well, it's too bad about Mom then. But I guess as moms go, she's about a three. I can deal with it."

"April!" They teach kids fuzzy logic in fourth grade now; nothing is either-or anymore—it's all on a scale of one to ten.

"Pete," Tamika said, "she's really just saying what Tad was saying—only being more honest. April, remember your ethics. What's the equivalent inverse situation to your donating a lung to your Mother?"

"Her donating a lung to me? Oh. I see. Do you think she would? Dad?"

What would you do, Jeanette? Would you come back from Mars? You wouldn't come back to raise your kid, but would you come back to save her life? Or would there be an excuse?

"Sure she would, kid." I said. Why make things any worse?

"If we lived," Tamika added, "in the sort of society where you would not make the effort to save her, it would also be a time in which, I think, she would not make such an effort to save you. Good deeds, I think, lend their way to an atmosphere of good deeds, so even if there is no direct reciprocity, all benefit. Meanness, on the other hand, leads to emulation as well. Be careful 'not to do unto others as you would not wish done unto yourself.'"

"Jesus?" April asked.

"In a way. But first, K'ung Fu Tze."

April sighed. "I feel heavy."

We were in skin-tight vacuum suits floating in oil, nominally in the zero gravity of neutral buoyancy. Still, there were cues. There was no oil in my helmet and my tongue felt heavy. I could feel the skin on my face sag.

Ahmed looked grim. He was transmitting in the clear. "They will make me shut off the beam soon. I am sorry. The beam from Phobos will arrive in two hours to push you back. Ahmed out."

But before his face vanished, he gave us a wink. Obviously, he thought we still had a chance.

"The splash is already getting dimmer," Tamika said.

I looked to my right, at the screen showing the ring center. The "splash" was where the incoming fairy dust blasted itself into plasma and was reflected by the magnetic field. It was dimming—that meant less energy. But I felt just as heavy—we were still doing four gravities. How . . . ? Of course!

"More mass, less velocity," I said finally. "Energy goes with mass times velocity squared, but thrust just scales directly with mass times velocity. Twice as much mass at half the relative velocity gives

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the same push, but needs only half as much energy. So the splash is dimmer.

"But that's not why he did it. The lower velocity stuff takes longer to get to us, so it has to leave earlier—he's figured out a way to send us all the push we need before they shut him down!"

"Does that mean his beam will still be pushing us when the Phobos beam hits us?" Tamika asked.

"Probably." I tried to imagine us caught between two blobs of plasma, one trying to push us to Mars, the other trying to push us back to the Moon.

"Dad," April said. "If we move a little, will our fairy dust follow our ultraviolet beam? Like Mr. Fahsi showed us?"

"Yes. Well, maybe." The sideways thrust of Ahmed's particles had to be minuscule. "*Korolev*, what kind of sideways delta v can the beam follow?"

"About half a millimeter a second at this distance."

"Get started," I said and focused my eyes on Polaris. "That way."

"We are already moving that way at almost a meter per second, to stay in the beam center. The beam is not tracking us exactly, so *we* have to track *it*. This is not normal, but within our limits."

"Of course! Ahmed's giving us some maneuvering room. OK, you give us half a millimeter a second at right angles to that, just in case the bad guys figure it out."

"Done."

"Can the Phobos mass beam find us," Tamika asked, "if we don't give it a UV beam to follow?"

I had a moment of hope, then remembered one of the redundancies. "Damn. Unfortunately, yes. Ahmed has corner cubes along the ring just in case the ship's UV lasers fail. As a back-up, the beam site can shoot a laser at us, and the incoming particles can follow its reflection as if it was our own laser." But, I thought . . . . "But not if we cover them. *Korolev*, can you cover the retroreflectors?"

"Not at this acceleration. My robot's servo motors can't lift their own arms in this."

"Why didn't Ahmed give them stronger motors!"

The question was rhetorical, but the *Korolev* answered it. "These are lunar robots that were put aboard at the last instant."

Of course. "Can we reduce the acceleration to what they can handle?"

"We can, but then we would not be in position to rendezvous with a deceleration beam at the end of the coast period. Also, I cannot reduce it quickly; the energy tied up in the reflector's magnetic field has to be radiated away and we don't have a full complement of radiators."

"How slow can you go and still make the rendezvous if you give it an hour?"

"Three point one four two gravities."

"Let's try three point two."

"My robots cannot—"

"Not your robots. Me."

I lift weights—most lunar folk do. The image of lunies as weaklings haunts us and some of us overcompensate; lunar weight lifters have won three Olympic weight lifting medals even though the population of the Moon is less than that of a large city on Earth. I even lift when I'm on Earth, where I was just a month ago. The human body has a lot of margin built into it; they say we can take four gravities almost indefinitely.

But, truth be told, I hadn't been lifting that much. When the *Korolev* got down to three point two gravities, I damn near couldn't get out of my acceleration tank. I learned very quickly that I had to plan every step. Over to the life support chest with the john in it—there was a tool kit in there as well. Rest standing—I didn't dare sit down. Over to the door. Rest.

When this was all over, my near middle-aged body was going to pay for it, big time. Every ordinary motion seemed to take an extraordinary effort—it was much more tiring, initially, than just the additional weight would suggest. I had to take the "door" panel off myself—we hadn't sealed and pressurized yet, but it

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still took fifteen minutes to get my head out of the *Korolev*'s cabin.

The "splash" was a huge, brilliant, violet ball below the ring with a spike stabbing up through it as a small portion of the plasma escaped along the magnetic field lines that went through the center of the ring. The black tube of the reflector electromagnet ran overhead through the center of the framework supported by big "X" braces every five meters—a ring within a ring. Actually, with all the force from the plasma being applied to the magnet, the ring frame was hanging from the loop rather than the loop being supported by the frame.

At my present weight, the lattice structure of the ring looked downright flimsy. There was a catwalk on its bottom, but it definitely did not look designed for someone to walk around on it at over three gravities. Not only that, but it wasn't immediately clear how I would get on it—what was an insignificant half-meter drop from the cabin frame to the lower longerons of the lattice ring in lunar gravity now looked like the bottom of the Grand Canyon.

You'd go down a wall like that by rappelling, I realized. It may seem ridiculous to rappel down a half meter door ledge, but that's just what I did, anchoring one of my safety tethers to the hole in a vertical longeron above the door. I wrapped the line around the shaft of a universal driver from the tool kit as a kind of friction bearing and used that to partly support my weight as I dropped one foot down to the framework and then the other.

Next to the cabin and a cross beam, the longeron held my weight. Still holding onto the safety line, I took a step out.

The frame bent under me, curving down over a centimeter, I guessed. The groan of composite longerons bending conducted its way from the abused frame through my feet and bones and into my ears.

"What's my margin?" I asked the *Korolev*.

"The stress on the frame is over the redline limits, but still twenty percent below expected strength. I am compensating for the frame distortion with active tension controls."

OK. I told the clip on the safety line to release itself, reeled it in, and stretched to attach it to one of the magnetic loop supports ahead of me. Supporting part of my weight with the safety line and part with my feet, I took a first tentative step. There were guide wires, but they didn't look like they would support any significant weight; I ignored them and hung on to the safety line.

The catwalk bent alarmingly, but didn't break. I took another step. This got me close enough to reach forward and attach my second safety line to the next support. I had to rest after the simple act of holding my arm above my head long enough attach the clip.

So. Half brachiating on safety lines and half walking, I got to the first retroreflector. It was a full five meters over my head—an insignificant height on the Moon, but a mountain in these circumstances.

Plan A had been to climb up there somehow and detach it with my tool. No way.

Plan B was my flare pistol. I took careful aim from almost directly below, bracing my shooting arm on the frame. The minirocket from my first shot missed to the right and I was rewarded by a brilliant flare high above the spacecraft.

The second shot hit the frame below the retroreflector's platform with a shower of sparks—and the smashed minirocket fell at incredible speed, missing me by a few centimeters. The third shot hit the right side of the retroreflectors platform and did nothing obvious. I put my arm down and rested. I could think of nothing to do but try once more.

This time, the platform tilted, breaking free on one side.

Another shot missed. If I could just hit it one more time . . .

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I did and was rewarded by the entire retroreflector falling down through the frame and into the plasma ball below me. It had taken almost forty-five minutes. I knew without asking that my act of half swinging on the safety lines was too slow. I would have to risk my entire weight to the flimsy catwalk. I resolved to move swiftly—things take time to yield and break.

Getting started was the hard thing, like diving into a cold lake. I knew it would probably work—twenty percent margin in theory—just like you know that, in theory, you'll survive that cold plunge into the lake. But I didn't feel that way. That catwalk could snap, dumping me into the white-hot splash ball below me. I stood there, frozen by doubt, and took another look up at our destination, as if that would fix my resolve again.

It did. As I looked, Mars instantly changed from its normal bright red to an incredibly brilliant purplish gray. They had started, damn them, and I still had two retroreflectors to disable. I turned to make my way back to the cabin. Pete, they've beaten you. Face it. You don't care that much. I could take getting beaten, but did I want April to see me give up this way—with her Mom's life at stake? Tamika's words haunted me—suppose things were the other way around? What if it were April's life at stake? Why the hell couldn't those idiots in charge of the mass beams and the lasers see that—it could be them! What business was it of theirs to stop me?

I became very focused. Risk to myself and other, feasibility, the whole ambiguity of my mission faded into the background. I was trying to do something and someone else was trying to stop me. It was now a contest of will and having come this far, I intended to win it or die in the attempt.

My anger gave me the surge of adrenalin I needed, and before I could talk myself out of it again, I turned and almost threw my right leg onto the catwalk.

Down it bent, but I had my left leg ahead before it finished bending. Walking on the catwalk between the X braces was like walking on a rubber sheet, but it didn't break immediately and I didn't stop long enough to find out if it would; it must have taken me less than two minutes to get another third of a circle around the ring to the X-brace of the second retroreflector.

I attached a safety line, sagged against it, and rested.

When I caught my breath, I shot the retroreflector off with five minirockets. Getting better, I thought.

But I was sore, terribly sore. There was a sharp pain in my right knee. There was an incredible tension in my neck, and I couldn't massage it in the vacuum suit. One more retroreflector.

I charged out along the rubbery catwalk faster this time and arrived slower and exhausted. It took me minutes to catch my breath and summon enough energy to raise the pistol.

With my body too tired to shake, my first shot hit right where I wanted it, and the retroreflector's platform tipped and fell back with a crash that set the whole X-brace vibrating. Out of alignment, definitely, but the thing about corner-cube reflectors is that they don't have to be aligned. I had to get it off entirely. One more shot would do it.

I pulled the trigger and nothing. The magazine was suppose to have twenty shots, and I'd only fired twelve. I looked at it; eight shots remaining. Did a minirocket misfire? Was it still sitting in the launch tube? Did I dare look? What would happen if it was and I fired another rocket into its ass?

I was tired, tired, tired. Three point two gravities were killing me.

Three point two gravities? I took the flare gun, pointed the launch tube down and gently tapped it against the X-brace. With a sudden clatter, the bad round fell out of the gun and onto the catwalk. It lay there, bright red and just as dangerous as the color suggested.

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Brilliant, Pete. Why didn't you, I asked myself, do the tapping with the launch tube pointed down into the splash? Now, do you just leave it there and risk either its propellant charge or its flare going off at some inopportune time, or do you knock it off the catwalk and risk triggering it then and there, with a foot or hand involved?

What was done was done. Recriminations could wait. Which way was the damn thing pointed? Toward the cabin, of course. It would knock a hole through it, fry the inside with its exhaust, and put another hole in the opposite side while it exited.

I took the universal driver, placed its ten-centimeter shaft next to the bad round, and gently pushed the little rocket so its nose pointed out away from the cabin and its exhaust end pointed in toward the center of the ring. It didn't go off. Maybe I could get rid of it entirely. No, I thought, don't borrow any more trouble. Leave it there.

I turned upward, neck protesting, and looked at the retroreflector's platform. I braced my arm, shot, missed, shot again, and the flare went off when it hit. I shut my eyes hard. The inside of my helmet stank, I realized. I didn't want to think of what the rest of my body would smell like when I got out of the tightsuit. I dreamed of a hot tub. If one had been available just then, I might have given up on everything else and jumped in it.

When I opened my eyes, I could see nothing but haze at first. There were lights and displays inside my helmet, but I couldn't see them. I waved my hand in front of my faceplate. Nothing. I blinked hard and opened them again. This time, out of the corner of my left eye, there was something. My air indicators which should be a pair of green, yellow or red circles were a kind of gray and shapeless blob. I blinked again—clearer this time. I let out a long sigh.

"Pete, Tamika." There was a lot of concern in her voice. "Are you all right? It looked like a minor nova out there."

"Tell me about it. My eyes are still recovering, bright spots floating around in front of me. I can't see the retroreflector. Is it still there?" How was I going to shoot it off if I couldn't see clearly?

"It is gone, Pete."

Done it. Somehow I'd gotten it done. The Phobos beam couldn't find us now until we wanted it to. But I needed rest; whatever energy I had left in me evaporated as soon as I knew I'd succeeded. I was literally sitting in the harness to which my safety line was attached—the legs were completely gone.

"I'm going to stay out here until acceleration stops; I can't move another meter."

"No, Pete," Tamika said. "We have to increase acceleration again. You need to get back to your fluid bed. Another sixty meters. You can do another sixty meters."

I groaned. "No way."

"Turn up your oxygen."

"Oxygen?"

"That's what those heavy professional athletes do on Earth."

"OK."

I focused on the left blob and said "up." It blinked, signifying an increase of five percent. I did that six more times and breathed deeply. My vision started clearing more rapidly.

"OK," Tamika asked. "Can you move now?"

I could.

"Come on, then."

OK, I told myself. If she wants me to do it, I should. I owe her. I gathered myself for one more mad slow-motion dash for the cabin that got slower and slower and slower and wobblier and wobblier. My knee was killing me, and halfway there I had to shut my eyes to concentrate on moving it, blinking open just often enough to put my feet on the catwalk. It helped somehow to forget about the goal however many meters ahead and just concentrate on moving my exhausted body.

I ran into something, of course. An

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X-brace. At least it was in a place where the catwalk didn't sag. Time to rest again, and this time, oxygen or no, I really had to lie down.

But I opened my eyes first, and found I was almost there. April and Tamika were there in the cabin "door," arms extended, urging me on. Just two meters left. Panting, I somehow held myself up, gained a little strength and hurled myself forward and in three heroic steps, crashed into the cabin wall. While I rested to gain strength for that one last climb into the cabin, I took one more look up.

Mars was red again. The Phobos guide laser had been turned off, or at least was no longer pointed in our direction. Whether it was Ahmed's random course shifts, our tiny maneuver, or disabling the retroreflectors, something had worked. We were going to get to Mars. Maybe in time.

Whatever memories I had of climbing back into the cabin and into my acceleration bed were gone once I woke up. It was dark, but I could see by the Mars light relayed by our viewscreens. Mars showed a visible disk now—better than halfway. Tamika must have sealed and pressurized the cabin—the normally tight parts of my vacuum suit were slack. I confirmed this with a glance at my helmet's heads-up display.

So I was able to take off the helmet for the first time in twelve hours. The cabin was completely silent—whatever fans were at work were too far buried to be heard. When they finish work on the *Korolev* it will rotate for centrifugal gravity, but for us, the coast phase of our journey was in zero gravity. How had I gotten here, I wondered. I remembered Tamika and April beckoning.

"Tamika?"

"Oh, you are awake. Thank goodness! We have about twenty minutes before deceleration. I have set up the shower. . . ."

Even in zero gravity, every muscle in me seemed to scream with pain as I moved.

Ahmed had not stinted on the shower—it cycled a gallon a minute—warm soothing water and hot air flowing over me and sucked into the grate below. If only the twenty minutes had lasted longer . . .

I listened to Ahmed's news conference on the way in to Phobos. He smiled; he was very polite; he only answered questions and told the truth—but he answered questions in such detail that I was sure Kelly would not be employed on the Moon much longer.

Nor would his immediate superior, who had acted against us without Tad Reynolds's approval and had thereby brought the weight of both official and public wrath upon himself.

I also learned that, so far, our effort was not in vain. Jeanette was still alive.

We were met in space off Phobos by an old-fashioned reentry shuttle—there was no time to go out to Deimos to take the elevator down to Ascraeus Mons. And no time for the press conference that would have entailed.

The shuttle commander and sole crewmember was a thin young woman with a very prominent nose and a smile to match. She met us at the door, towed us to our seats, and saw that we were strapped in. We hopped over to the Phobos maglev port and in minutes were on a trajectory to the Jovis Tholis dome. As soon as she cut the rockets, she asked for everyone's autograph.

April slept until the landing. But Tamika had something to say.

"Jeanette wants more than a new lung," she said.

So I had to face it. I opened my mouth but nothing would come out.

"Life," Tamika said, "doesn't always let us be happy. If you choose to stay with Jeanette, I will hurt, but I will be able to deal with that. I understand the beauty of restoring something that was once broken, and how that would appeal to you. If you weren't like that, I

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wouldn't love you so much. So I can't have it both ways, can I?"

We were strapped into seats across an aisle. I couldn't hug her—or be hugged.

"You are a real philosopher, Tamika," I said, and mouthed a kiss at her.

She shook her head and I could see tears in her eyes. "No, not so philosophical now. Now I am just a woman begging for her man. What philosophy that I can give you is that when you cannot be happy yourself, at least do that which creates the least unhappiness for others."

"Tamika, I . . ."

"No. Tell me after you talk to Jeanette. For you will not have really decided until then."

"However I feel about Jeanette, I still love you."

The roar of our entry into the Martian atmosphere made further conversation impossible.

Everything is efficient on Mars—we were met by a robot ambulance with its own universal pressure ramp. Dazed, the three of us unstrapped ourselves and followed the shuttle pilot in and were on our way. April was under anesthesia less than two hours after touchdown on the Jovis Tholis university field.

Three hours later, Dr. Lada Baklinova told us that the operation was a success. Jeanette was already breathing on April's lung, a new heart was starting to bud next to the artificial one, and a new lung was growing in the left cavity next to that. Her prospects were excellent. Aside from the injuries, Jeanette was a strong, healthy woman and it turned out that there'd been little deterioration inside. She'd tolerated the stuff they use to help the prostheses very well. She probably would have lasted a week or two. But it was good that we came as quickly as we had, she said.

If we'd gone at one gravity, I thought, someone would have had time to figure out a way to stop us.

* * *

A week later, they brought Jeanette out of a "recuperative coma" and she asked for me. So I was alone, face to face, with her for the first time in eight years. Whether it was fluid retention, relaxation, or something they had given her, her face, as much of it as I could see anyway, looked a dozen years younger. She was radiant.

"Pete, I'm terribly sorry," she said before I had a chance to say anything. "My mistake. I just got caught up in things, really lost sight of priorities. I should have a family, I should belong. Pete, this is a great place to be a family . . . they're already allocating land. If you get in at the beginning, you could get hundreds of square kilometers—we could found a dynasty. The divorce was a mistake—let's undo it, start over."

I shut my eyes. I could have it. I could recover a quarter century of my life and give it meaning again.

All I had to do was betray the only truly good person I had ever met. I would never be happy with myself if I did that and I would spend the rest of my life wondering "what if" if I didn't.

"I can't promise anything, Jeanette." Coward, I called myself. Make a decision.

No, I realized, it wasn't solely mine to make. "April needs to be part of this, too."

"This is too big, Pete. She's only twelve."

"Thirteen, Jeanette. She turned thirteen the day before yesterday." We'd gotten a ride to Olympus Mons from Jeanette's boss. He had a lot to say about Mars and little to say about Jeanette other than to call her a "brilliant, determined woman."

Jeanette shut her eyes. "Five. Thirteen. I've been busy."

"I'll call her in."

April came in and looked uncomfortable. "Hi, Mom, I gotta monster scar."

Jeanette smiled more brightly than was natural. "I'll bet you do. Thank you, darling. Thank you so much. April,

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honey . . . Pete. Isn't this a wonderful new world?"

I nodded. Next to Luna, it was huge and sprawling. Next to the Earth, uncrowded with lots of elbow room.

"There will be rivers here—and forests. We can be among the first homesteaders. Everyone who's on Mars when they decide to open it up can claim a few hectares. They're starting to give it an atmosphere. In a century or so, we'll be able to run, breathe, swim, and play."

"You're planning on living forever?" I asked.

"I don't see why not. The genetic engineers are close. Very close. Pete, you could share it with me. Forget the divorce, we can remarry instantly. Jovis Tholus dome is five kilometers in diameter and only a tenth of it is allocated. You could go to high school here, April. You'd be one of the first graduates. We could be a family again, just like before."

April's eyes got wide, but then she frowned. "That's kinda like putting a broken egg back together, huh? Mom, this one is pretty broken." April looked up at me, eyes glistening, then bit her lip and tried to look very, very adult. "But I'd like to live on Mars. Could Tamika live with us, too?"

Jeanette opened her mouth to say something, shut it again, composed herself, then said. "I wa s thinking just us. On Mars, you only have one . . . person. IPA laws—Mars is a joint project. Anyway, I'm not sure Tamika would go along with that. She'll do OK, April. She did before."

"On the Moon, lots of people share. It's no big deal. Why don't you come back and live with us?"

"April, there's this big new wonderful world. Besides, that . . ." Jeanette obviously struggled for words, ". . . wouldn't be fair to Tamika."

"Huh? She's OK. Look, you want to be part of a family again or what?"

"April!" Jeanette sounded stern. That was a lot of pressure to put on the kid. I wanted to say something sharp, but suppressed it.

April suddenly got a frightened look on her face and threw her arms around me. "Daddy, why does it have to be so hard?"

Why indeed? Leave it to April to suggest a way to have my cake and eat it too—when you're that young, anything seems possible. By middle age, there's just too much social baggage. "I think you were right about the broken eggs, darling. But Jeanette will always be your mother. And there will be plenty of time to be together in years to come. Especially if she's right about living forever."

I smiled and took April's hand and put in Jeanette's. In a minute they were both in tears and April—very carefully—buried her face in her Mother's shoulder. Jeanette closed her eyes for a moment. When she opened them, glistening, I knew she'd given up.

"I'm very sorry, April," she said. "Once in the while the universe lets you put a broken egg back together. We got one put back together—me . . ." She looked up into April's eyes for a moment, then down. ". . . so I guess we should be happy with that." She turned her face up to me. "I'm sorry, Pete, I love you both as much as I can love anyone and always will. And I'm very grateful." She sighed and pursed her lips. "But I have to be true to myself. I have to be out here, exploring—that's always going to come first for me. I'd love to have you to come home to, but . . . but let's keep in touch, birthdays and things, good memories, OK? No hard feelings?" She squeezed my hand and April's.

Dr. Lada Baklinova came into the room then.

"Time to let her sleep, now."

I nodded. It was also decision time. The Martian authorities had taken one look at the *Korolev* and said, privately, that they couldn't in good conscience let anyone go off in space in that unless it was an emergency. Strange things happen, true—but they were betting that it

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would be several decades before anyone got to Mars from Luna in one day again.

The CLS Von Braun was due out today, but they were holding her in case we decided not to stay—the celebrity treatment was Tad Reynolds's doing. He was trying to make amends. But the next ship out wouldn't leave for three months, and that was a four-month voyage with a Venus flyby. The Von Braun could get us back in ten weeks.

"Jeanette. They've got a ship waiting for us. We've got to go home now. Planets don't wait."

There, I said it. I had in my hands what I'd dreamed of for all those years was offered to me, and I turned it down. Except that it really wasn't my dream. Five. Thirteen. However long we all lived, I'd never get those years back.

She nodded, but locked her eyes on me and pleaded one last time.

I shook my head, knelt by her bedside, reached gently across her, and kissed her one last time, for the memories. All the hurt came back, but it would have been wrong not to do it.

April kissed her mother good-bye, too. For the last time as a child, I thought. Five. Thirteen. Probably twenty-one by the next time they met.

There were no more words and we left, somehow stumbling down the corridors to the reception area. Tamika met us there and herded us, dazed, through the vans, the suborbital shuttles, and up the high-speed elevator to Deimos for the ten-week trip back to Luna.

As we approached the CLS Von Braun, the sun sparkled off the huge butterfly wings of her radiators and lattice work of her ion accelerators. They reminded me of the sails and halyards of yet another bygone era.

What do we gain?

April hugged me. "She's really more like a six or seven, Dad. Too bad."

Tamika laughed and pointed at herself. April instantly held up ten fingers.

I looked down on the rusty cloud streaked globe of Mars where my first love would make her life.

What do we give up? ■

There is no reason to be amazed because the ordinary person believes anything [based on a hoax]. Belief is natural and pleasant. The child begins life by believing everything. He has to be taught skepticism before he will doubt that there is a Santa Claus, or that the moon is made of green cheese.

—Curtis D. MacDougal

Let's not be too quick to blame the human race for everything. We must remember that a great many species of animals became extinct before man ever appeared on earth.

—Will Cuppy

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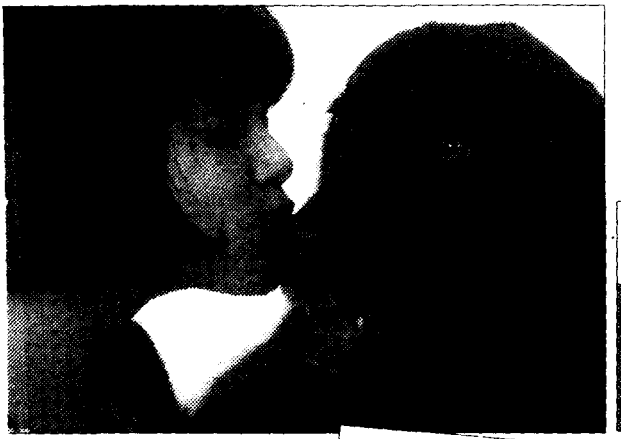

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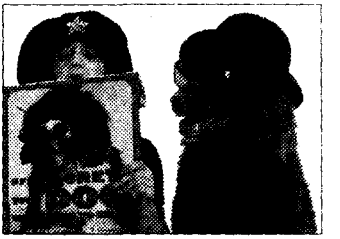

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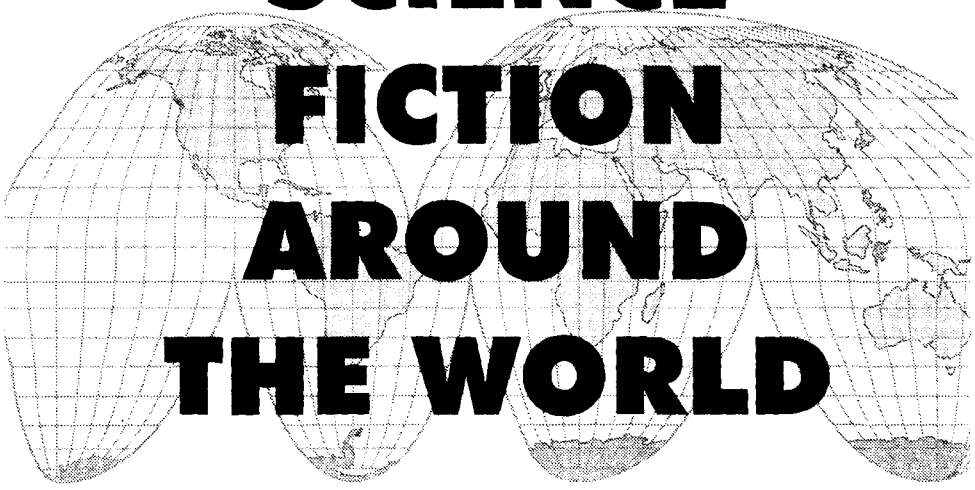
James Gunn

SCIENCE FICTION AROUND THE WORLD



I

I have just completed putting together *The Road to Science Fiction #6: Around the World* and have been exposed to a broad spectrum of stories categorized as science fiction. I have discovered, however, that there are distinct national differences that have something to tell us about science fiction and the way it has interacted with social history.

Science fiction, which today seems as American an export as Coca Cola, actually got its start in Europe, where the Industrial Revolution created the first and sharpest recognition of the way technological change was reshaping human existence. The earliest example, Mary Shelley's 1818 *Frankenstein*, was followed by stories very much like science fiction, written between 1830 and 1860 by U.S. writers Edgar Allan Poe, Nathaniel Hawthorne, and Irish immigrant Fitz-James O'Brien—but even earlier, between 1809 and his death in 1822, by German romantic novelist and composer E. T. A. Hoffman. By the middle of the 1860s, however, a new kind of fiction clearly had come into existence, its creator was France's Jules Verne, and his medium was the *voyage extraordinaire*.

England's H. G. Wells, more sensitive to the social forces gathering to transform existence, wrote scientific romances that brought idea-centered fiction to the service of this new literature. In Germany Kurd Lasswitz wrote three SF novels at the turn of the century, in particular *Auf Zwei Planeten* (1897). And throughout Europe authors of lesser note were writing novels about inventions and fantastic travel, and something almost like SF magazines were being published.

Nevertheless, the 1926 publication of the first American SF magazine *Amazing Stories*, by Luxembourg immigrant Hugo Gernsback, his 1929 creation of *Wonder Stories*, and the Clayton magazines' 1930 addition to its pulp-magazine chain, *Astounding Stories of Super-Science*, provided the catalyst for the transformation of the extraordinary voyage and the scientific romance, together with the imaginary journey, the fantastic

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satire, and the utopia, into the genre that is recognized today as science fiction. Looking back upon that period of evolutionary development, readers may wonder whether it would have happened without Gernsback or without John W. Campbell, Jr., who took over as editor of *Astounding Stories* in 1937, transformed it into *Astounding Science-Fiction* and then into *Analog*, and guided science fiction into what later became known as the Golden Age. Or what SF would have been without Robert A. Heinlein or Isaac Asimov, or a number of other Golden Age writers.

In the introduction to *The Road to Science Fiction #5: The British Way,* I commented that "America has always been perceived as a place for new beginnings, first for religious freedom, later for economic opportunity, and between the two the frontier beckoned as the ultimate alternative to stagnation and despair." Americans looked for guidance not toward the past but toward their anticipations of the future. The American situation may have provided the necessary conditions in which science fiction could take root and thrive.

Science fiction blossomed in the United States, and in the process science fiction acquired an American accent that it has not lost to this day. In contrast, science fiction in the rest of the world emulates the American stories and novels that have been translated into the local language and that readers in those countries recognize as having "the right stuff," or it defines itself against the American type, or it pursues its own particular genius. But why didn't science fiction become a French genre, say, or a German category? It got started there first.

II

The United States picked up the extraordinary voyage and the scientific romance, put them together in magazines, and called the result science fiction, while Europe allowed these kinds of stories to exist in relative isolation, without the synergistic combination of reader interest and commercial profitability. In the U.S., the desire of the newly educated working classes for reading that involved but did not intimidate and the opportunity of entrepreneurs to make money publishing adventure stories of various kinds led to the pulp magazines, one type of which was the SF magazine. The science fiction magazines were only modestly profitable at best, but the loyalty of readers (some of whom organized themselves into fandom) often assured a financial return.

SF magazines did not spring up in Europe until much later, and only then in response to the American magazines–often when they were translated. Audiences were small and European countries lacked the pulp magazine tradition from which the category magazines could evolve. The pulp magazine may have been the necessary seed-bed for the development of the SF magazine, although I have argued that the reason the SF magazines survived the general demise of the pulps was because its origins lay not in the pulps, but in the popular-science magazines.

Two world wars and a depression that hit even harder in Europe than in the U.S. also may have contributed to the failure of European SF to develop as significant alternatives, as well as the political turmoil of the Communist and fascist movements. Faced by uncertainty in economic, political, and social institutions, Europeans may have had difficulty believing in the possibilities of a better future. Psychologically then, readers, writers, and publishers in Europe were unlikely to find science fiction a congenial medium. Moreover, without a pulp SF tradition to set the genre apart, science fiction in Europe remained far more a part of the literary mainstream.

III

Perhaps the most important distinction is science fiction's worldview, that I have described in greater detail else-

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where: the Darwinian concept of human adaptability modified by science fiction's belief in the human ability to recognize its adaptation and choose to behave otherwise. These two basic principles create that difficult-to-define something by which we identify science fiction; and if the literature at hand doesn't involve them, we may feel that it is *like* SF but doesn't quite have the right stuff. At least that is true of American SF. European SF, I feel, is more like the British New Wave. It tends to describe the environmental aspect of human behavior but, like naturalism, stops at that. A good deal of European SF does not involve American SF's second assumption: the ability to act other than the way one is conditioned to behave; and some of it denies human adaptability, assuming instead that traditional responses will remain constant even during periods of significant change.

All of this has little or nothing to do with the way people behave in the real world. Most of the time people do behave as if they were programmed by their environment, but occasionally they act as if they have free will. American SF has focused on the problem-solvers who have done the most to change life and society and thereby, according to American SF, people themselves. Other SF, including much that I have identified as European, bases its stories on the more common form of behavior.

Mainstream fiction seems to do without Darwin entirely. In a mainstream story, the origins of humanity—if they enter at all—are more likely to be biblical than evolutionary.

The basic orientation of the American reader is practical and pragmatic, but the European reader responds more readily to the psychological than the physical, and finds fantasy more congenial than American science fiction, because of the length and power of European tradition and because the archetypes of myth and folklore reflect more accurately the realities of European experience. To put it another way, European readers are likely to be more sophisticated in their reading skills and attitudes, more skeptical of human accomplishment, and more cynical about human ability to transcend its conditioning. Having made those observations, however, I must add that the substantial European readership for American SF in translation suggests a sizable body of European readers who are more like American SF readers in tastes and attitudes, just as there are many American SF readers with reading skills and sophistication (and cynicism) the equal of any European. The differences I am describing are those evident in characteristic science fiction and readership.

Even in the United States, fantasy—particularly the kind that deals with the inexplicable or the supernatural in everyday life—has never been segregated from the mainstream of literature as have the other categories, the detective story, say, or the western, and particularly science fiction. In Europe, the mainstream toleration of fantasy has extended even to science fiction, and one is tempted to speculate that the division between "serious" literature and what is known in the United States as "paraliterature" is either non-existent in Europe or minimal. Perhaps the mechanisms that set apart paraliterature in the U.S.—the dime novels followed by the pulp magazines—never existed or were not as powerful in Europe. In addition, in a number of countries, including the Soviet Union and China, science fiction was considered a branch of children's fiction (as were Jules Verne's novels in his time, and the dime novels and the boys' magazines in the U.S.) and tolerated for its ability to teach scientific ideas to or instill scientific ambitions in the young. But it was not held up to the same standards as adult fiction, nor tendered the same respect.

The origins of international science fiction lie in the mainstream, not in the pulp magazines where American SF

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developed beginning in 1926. In Europe major writers such as Franz Kafka and Italo Calvino were using SF concepts or concepts like SF, as well as Stanisław Lem in Poland, Karel Čapek in Czechoslovakia, Jorge Luis Borges, Carlos Fuentes, and Gabriel García Márquez in Latin America, and Kobo Abé in Japan. That evidence of respectability helped sustain SF within the mainstream in those countries and influenced their successors.

Science fiction developed alongside industrialization. It had its origins in the Industrial Revolution and has taken root most readily where industrialization has provided evidence of social change, and with greatest difficulty where agriculture, with its links to the past and sense of tradition, has remained the dominant economic activity.

IV

The premises that underlie fiction shape it in characteristic ways. American SF, with its beliefs in a knowable universe, human adaptability, and the ability of rational beings to resist environmental conditioning, characteristically presents a situation in which significant change has occurred and created a problem: how will people adapt to the change, or cope with it, or recognize an adaptation that must be countered if humanity is to survive or achieve its self-defined or destined goals? The American SF situation is complicated by the efforts of the characters to resolve it in whatever way seems appropriate and is finally resolved by the characters discovering some hidden truth or re-evaluating the real nature of the situation. One version of this story is called, by *The Encyclopedia of Science Fiction*, "conceptual breakthrough." Readers can recognize it in stories and novels that range from Robert A. Heinlein's "Universe" and Isaac Asimov's "Nightfall" to James Blish's "Surface Tension" and Hal Clement's *Mission of Gravity*.

The basic structure of American SF is the classic plot skeleton for the short story itself: situation, complication, resolution. Sometimes the order is inverted, with a discovery of the situation arriving at the end as a kind of resolution. Sometimes the elements are present only by implication. At its worst this kind of structure can result in a formula that produces stories both predictable and false to experience. At its best it can provide a structure as valid as life itself. The test is the kind of story that is shaped around it, its relevance, its insights, its language.

But what the American SF story suggests is that the basic human attribute is problem-solving (John W. Campbell, in his 1934 story "Twilight," called it "curiosity") and that the problems that people encounter can be solved, or are, at least, susceptible of solution even though the people to whom they happen may not be able to solve them. That, of course—or a belief in it as a starting point—is the American experience. It is also the position of science.

The position of the literary culture, as C. P. Snow identified it in his 1959 "Two-Cultures" lecture, is that tradition is a better guide to behavior than science, that culture is more important than the physical conditions under which people live, and that "progress" is illusory and represents a loss of spirit or soul. This has been the position of the British literary culture from Blake and Ruskin and Arnold through the adopted Englishman Henry James and D. H. Lawrence up to the present. E. M. Forster's 1909 "The Machine Stops" in *The Road to Science Fiction #2: From Wells to Heinlein* is an early SF statement of that attitude, just as John W. Campbell's 1934 "Twilight," in the same volume, though similar in situation, ultimately adopts the opposite viewpoint.

The attitude of European science fiction seems more like that of the literary culture than like that of American SF. In European SF (with exceptions) the

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change encountered by the characters in the situation is usually a given whose origins are obscure or undefined, the complications are internal rather than external, and the resolution restates the intractability of the human condition. To most people, this represents their experience of change, and in this respect, as well as others, European SF is more "true to life," in that it reflects the chaos or indeterminacy or absence of closure of real life. I put "true to life" in quotes because it is a phrase that is impossible to verify. Life has many aspects, and one must choose which aspect to be "true" to. American writers might say, moreover, that readers turn to fiction *because it incorporates* the order, the sense of justice, that real life lacks. In fiction, actions have consequences and people earn their fates. It may be from fiction that we learn the concept of justice that we apply to real life.

Nevertheless, a difference in viewpoints gives both versions of science fiction their characteristic shapes. To European readers I would say, "Other attitudes toward what is possible or what is proper for humanity will result in different kinds of fiction. Neither is inherently superior." To American readers I would say, "Don't be put off by the fact that many international stories seem different. They have another view of existence than the one that shaped the SF with which you are familiar. See what they have to say."

V

Science fiction can be found in many areas of the world that I haven't touched upon. Holland and Belgium and Hungary, for instance, have science fiction and Bulgaria and the former Yugoslavia, Israel and Turkey, and Ghana, and possibly other nations in Africa, including South Africa, do as well. In Latin America, Brazil, Chile, Uruguay, and Colombia, and no doubt other nations have SF. And in the Far East, there is SF written and published in China, Hong Kong, Taiwan, India, and Singapore, and other areas. Japan, with its postwar industrial development, has achieved a major SF presence.

The traditions of science fiction in many areas of the world, however, are short and difficult to untangle from the general thread of fiction, and sometimes the fiction itself has just emerged from the oral traditions of myth and folktale; sometimes the nations themselves have been in existence too short a time to develop a science-fiction tradition; often industrialization has come too recently to produce a literature of change.

What I attempted to do in the sixth volume of *The Road to Science Fiction* was to look at a dozen areas of the world and their fictional responses to the industrialization process that has created irreversible change in the way people live and work, and even the way they think about themselves and the universe in which they live. Those responses vary according to the area of the world in which they occur and the traditions with which they must interact. The anthology attempts to trace the various roads that science fiction has taken as it struggles to make the Earth one world and its races one people. The two stories that follow, one originally published in East Germany, the other in Czechoslovakia, illustrate the ways in which science fiction springs out of any soil but in a form shaped by its environment. And yet its relationship to science fiction everywhere is clearly recognizable. ■

[Editor's note: *The Road to Science Fiction #6: Around the World* will be published in July by White Wolf.]

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Alexandr Kramer

That Invincible Human Spirit
or
The Golden Ships

Translated by Nora Hronková
Adapted by James Gunn
Introduction by James Gunn

Political Writing

Getting published in the United States or Great Britain meant meeting the standards of a particular editor. Getting published in Eastern Europe was often trickier: publication had to get past censors and even those narratives that made it into print might still get their authors into political difficulties. Contributors to American SF magazines understood, until relatively recent times, that they could not write about sex or bodily functions, and editors preferred upbeat endings, but nobody cared what an author said about politics; in Eastern Europe, politics was the touchy area. Just as U.S. writers tried to get sexual references past the editors, so Eastern European writers worked at getting across their political message.

Sometimes the problems were even more difficult. Take the case of Alexandr Kramer, a Czech journalist. Born in 1946 in Prague, Kramer got involved in the student movement at Charles University in the late 1960s, when the pro-democratic activities that got started in 1963 culminated in 1968 with the installation of Alexander Dubček as party leader and Ludvik Svoboda as president. In August a Soviet-bloc force occupied Czechoslovakia and the following year it replaced Dubček with Gustav Husák.

Kramer, who had joined the Communist Party in April 1968 with the installation of Dubček, left it in November 1969, and the following year was expelled from the University (he returned to get his degree in journalism

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and social sciences in 1990). From 1970 to 1990, prevented from pursuing a professional career, he did various odd jobs, and for a dozen years he translated technical manuals. In January 1977 he signed the famous "Charter 77" human-rights manifesto—an act that put him automatically on the list of the Communist regime's worst enemies.

Meanwhile, he had begun writing science fiction short stories. He had no hopes of getting them published under his own name, so his first collection, Experiment for the Third Planet, *containing stories by Kramer and Jaroslav Veis, was published in 1976 under the name of Veis alone. In 1979 the same thing happened with* Pandora's Box. *Both books were extremely successful in Czechoslovakia and helped make Veis the leading SF author of the time. In 1986 Kramer published* Everything is Different, *a history of world science fiction, with another friend, Ondrej Neff, and under Neff's name, and in January 1990, another collection,* Exodus with a Happy Ending, *entirely his own but published under the name of another friend, Miroslav Kostka, because the book had been printed two months before and it was too late to change.*

That was just after the "velvet revolution" that elected Vaclav Havel, a political uprising in which Kramer participated. Kramer also got stories published in several anthologies under Kostka's name, did some translations of stories by Asimov and Sheckley, and under the name of Veis published a five-part series on world SF and under the name of Neff, a ten-part series on modern SF. He also wrote most of the English and American entries in the Czech Encyclopedia of Science Fiction Literature *(1995). The situation resembled the blacklists of U.S. film and television writers that followed the hearings of the House UnAmerican Activities Committee in the early 1950s.*

In 1990, however, Kramer picked up the journalism career he had been forced to abandon twenty years earlier. He became editor of the foreign desk for Lidové Noviny, *for which he had worked for six months while it was still clandestine. He studied in the U.S. and reported on the visit of President Havel and the 1992 presidential elections, served as head of the foreign service for the CTK press agency, headed the foreign desk of* Mladý Svétl, *served as deputy editor of* Týden *newsmagazine, and served as editor for Radio Free Europe, Prague.*

After the revolution, Veis, Neff, and Kostka tried to let the SF-reading public know the truth about Kramer's authorship, which may have led some to attribute Veis's and Neff's own stories to Kramer. Perhaps Kramer's latest collection, That Invincible Human Spirit *(1997), assembling virtually all his stories in one volume, will get all that straightened out.*

Those lousy, stinking ships! It was them that destroyed us. Don't let anyone tell you different. I know, these days those crazy prophets and preachers—you ain't one of them, are you?—they've started going from cave to cave, trying to tell us that it wasn't really those ships, but we ourselves—

An opinion poll, you say? You want me to tell you everything I can remember and give you my opinion of it? . . . Why should I do that? What's in it for me? Our descendants? Are you so sure we'll have descendants?

But who cares—there's plenty of time. Okay, then—I'll tell you what I think about it all. I can still think straight, see, even in all this mess. And I can remember it all, like it was yester-

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day. So if your brain ain't been softened by strontium—

Maybe it has. Maybe you've forgotten what a wonderful life we used to have. All those *things* we used to have. Television, cars, air-conditioning, fridges full of vacuum-packed food and beer. That marvelous beer you could get anywhere! No, mister, you can't forget that—that was civilization, see?

And that's not all, not by a long shot. We had lots and lots more than that before . . . before they came. The golden ships. Twentieth of June, 2009. No one's going to argue that date with me; it's a date engraved on my memory and painted black. At half past seven in the morning. That's when it started—and in a week it was all over.

No one saw them fly in. I'd say that's what frightened a lot of people the most. The top brass could stuff all their radars, detectors, and what have you. Suddenly they was there. Huge golden pipes, shining in the sun like an ad for a new brand of cigar. Except that no new brand of cigar came on the market then. Nor earlier either—

And certainly not later.

The guys who took money for knowing about things like that said those funny cigars were hanging three kilometers above the earth's surface. And right away they were sure they couldn't be anything but alien ships from somewhere in space. They said that our long-expected visitors finally were here. The trouble was—a bit unexpectedly.

Talk about a visit! I tell you, mister, there was a panic if I ever saw one. Remember how the newspapers carried on? And the suicides? Everybody suddenly went off their head, some from fear, some from delight, the dumbest out of simple curiosity. What about me? I was scared shitless, I can tell you, mister, because it was clear as mud to me from the start that those lousy golden gadgets could bring us nothing but a load of misery.

The first day was a real mob scene. Police and soldiers ran around with clubs and rifles, and I bet several hundred people in every big town kicked the bucket in auto accidents alone. And then that silence, full of uncertainty and fear! The waiting to see what the jerks we voted for in the last election would do—

Well, you remember, the politicians did the only thing they've really been good at since the days of Christ. They washed their hands of the golden cigars. And they passed the buck to the doctors and scientists of all the branches of science there was in the world. They put them in planes, set them down in front of transmitters and computers—like they were supposed to make contact with extraterrestrials. Contact, my bleeding ass!

But the extraterrestrials—damn them! Can you imagine? Delegations from the United Nations, every possible kind of egghead, politicians, the Pope—all sorts of people turned to them, welcomed them, warned them, sent messages of world-shaking importance—and those lousy bastards . . . ! Damn them! They went on calmly squatting in their golden pipes and didn't react at all. They hung up there in the sky just like it belonged to them, and even had the nerve to direct rays of sunlight at us.

Do you remember what democracy was like? And public opinion? Go take a look at the seashore when the tide comes in, a couple of hours from now, and the waves come rolling up the beach. And then imagine a wave ten times, no, a hundred times higher, of human confusion, anger, fear, hatred, madness. . . . That was the second day, mister. When people heard from TV that "all attempts to make contact with the extraterrestrial ships have so far been unsuccessful," they swarmed into the streets. They looted the shops, murdered, raped, demolished stores and offices, started fires. . . . The army was told to use live ammunition, and when they got the situation under control by nighttime, they had to send trucks and front-

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loaders into the streets to clear away the dead bodies. By morning we had a military dictatorship.

A change like that was hard to get used to, you know? But it made no difference to the main thing. Democracy or dictatorship, the golden ships still hung in the sky and shone provocatively. Do you get how damned cheeky that was? The danger that threatened us? By now it was perfectly clear to everybody that what was hanging above our heads was no visit but a crude invasion. Crude and treacherous. Everyone who wasn't busy burying their dead—and some of them, too—all of us were waiting to see what the new government would do—what it *could* do.

And I tell you now, mister, that nobody should blame the generals. They did what they could and, after all, it ain't their fault that—

Well, yeah, it was complete nonsense to try conventional weapons, but who could guess that from the start? Anti-aircraft guns, fighter planes, air-to-air rockets and machine guns—who was to know that all that would be no more use than tickling an elephant with a straw?

And the generals caught onto that pretty quick, you gotta admit. In less than two hours ground-to-air rockets were swishing through the air.

I'll swear that each one of those gold cigars must have copped at least a hundred hits, dead-on. And yet—

Damn them all! They didn't even budge, and nobody could even see a scratch on them. For three days and three nights our armies hurled the highest-powered missiles at them—and it wasn't even worth their while to spit. They just laughed at us from up there.

The first military government fell on the fourth night, when the general at the head of it suggested surrender—and on the morning of the fifth day things really began to get mean. That was when the real uglies moved in and the TV said we was all to get to the shelters. We knew what they meant—the old atom-bomb shelters that nobody thought we'd ever need.

Well, I admit, mister, I didn't see that final shoot-out with my own eyes. You can't see the sky from a shelter. And by some miracle I was one of the lucky few who managed to find a decent shelter. But so did you, eh? That's why we're here and able to talk together.

You must have heard that booming. We were fifty meters underground, and we still heard it. It must have been complete hell up there. Hiroshima was nothing. A-bombs, H-bombs, N-bombs—they sent up everything they had, including some that nobody never even heard of. And yet—

Damn! You remember, *mister*? You must remember. How a few days later—or maybe it was only a few hours—you know, I can never be sure about that—how we crawled out and the first thing we did was look up—at the sky—not at the ruins all around.

There they were, of course. Those lousy gold cigars, motionless, shining. Immune to the world that had almost disappeared just a few kilometers below.

I don't know, mister, how many of us got isotopic strontium in our bones in those next few days, months, and years—I never did understand all that stuff. But the main thing for me is that I'm still here—alive. And there are quite a few of us. You know what I mean? It's true we're scattered in little groups, we live in caves, suffer from all kinds of sickness, cold, hunger. . . . But we've preserved our invincible human spirit, mister. We're still here, they didn't manage to destroy us completely, and we can go on hating them.

You got that? You must know what I mean. As long as we're here, there's still hope.

That one day we'll pay them back. For everything. For *all they've done to us*. You know, one day—

But in the meantime . . . Just look at them, mister, hanging up there. Those lousy, bloody, golden . . . Doesn't it make you sick?■

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Erik Simon

Ikaros

Translated by Vernon A. Chamberlin
Adapted by James Gunn
Introduction by James Gunn

Illustration by Shirley Chan

The Meaning of Walls

The reunification of Germany came as a shock to most East Germans. Suddenly, after more than 40 years of austerity and restrictions on movement and speech and writing, people could travel freely, say what they wished, and write without censorship. But they were also free to be unemployed, to be unable to afford the goods everywhere around, to have nothing to say or to write.

Behind the Iron Curtain that was symbolized in Germany by the "Berlin Wall," people were protected from the extremes of deprivation. That applied to science-fiction writers, as well. About a dozen new SF books were published each year in the GDR, but print runs were in the hundreds of thousands, books often were reprinted, and with reprints and the low cost of living, a writer could survive by publishing a book every three years. When Germany became reunified in 1990, all *that changed: books had to compete in an market overcrowded with American translations and Perry Rhodan pulps, and print runs, and sales, of original German books became limited. "In 1990," one such writer and editor, Erik Simon, has written, "nearly all East German SF writers fell silent." Perhaps the greatest problem, Simon believes, may be the absence of a professional SF magazine. Several attempts to establish one have failed, although the East German* Alien Contact, *founded in 1990, became more promising when it reverted to semi-professional status.*

The reasons for the difficulties of East German authors were not all related to the marketplace. The pace in the GDR was slower and the understanding between writer and reader (they shared "the same set of coordinates") was greater. Reunification meant an experience of "general

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disorientation." East German editors also had time to work with writers in a way that overburdened German editors do not. Even the loss of censorship made life more difficult. East German readers were trained to read between the lines for the little hints carrying a political message that might slip past a censor. That kind of care meant better reading for all kinds of texts.

Simon, born in Dresden in 1950, earned a degree in physics, specializing in experimental cryophysics, from the Technical University of Dresden. He wrote his first SF story in 1970 and took a job in 1974 as SF editor for an East German publishing house, Das Neue Berlin. He has written only short stories and published them in three collections: Die ersten Zeitreisen *in collaboration with R. Heinreich (1977, "The First Time Travels"),* Fremde Sterne *(1979, "Alien Stars"), and* MondPhantome, Erdbesucher *(1985, "Moon Phantoms, Earth Visitors"). They have been translated into Bulgarian, Czech, Polish, and Swedish; his stories also have been translated into Hungarian, Russian, Slovak, Ukrainian, and Spanish. Simon has edited twenty anthologies and an encyclopedia of GDR SF.*

Simon lost his job in 1991 when the publishing house stopped publishing SF, unable to compete; the house shut down completely in 1993. Now Simon, never a prolific writer, works as a translator, mostly of American SF, and produces one or two stories a year. He won the Kurd Lasswitz award for one story and took second for another.

"Wissenwertes uber den Planeten Ikaros" was written in 1971, but it means more to Simon now than it did then. Its premise, that he did not recognize at the time ("nor did the censor, or any of the critics"), "was born out of the specific existential situation in the GDR of being immured." *Nobody could have known then that the image of a hollow planet implied not only the situation of being enclosed but "also the way many East Germans (at least many of those born before 1965) feel now, after the collapse of their small but safe prison, finding themselves in a hostile universe, under conditions which they didn't anticipate and which they still cannot get used to."*

Ikaros (2)—Only planet of the double-star Orn (*cf.*). Nearly circular orbit, large half-axis 2,203.8 million km. Orbital period: 15,010 Earth days. Equatorial radius: 5,800 km; Mass: 0.32 Earth. Discovered: 893 N. T. by Interstellar Expedition (*cf.*) XXXII.

Planetology: I. is composed of three layers: a) Atmosphere: rare gases (Ar, Kr, and Rn); hydrogenated carbons, with traces of CO_2, N_2, and O_2. The atmosphere is thin; at the height of 200 km it is no longer perceptible. b) A rock surface extends to a depth of approximately 1000 km. Most important elements: C, O, Al, Si, Fe, Co, Ag, and Pb, heavy radioactive elements (predominantly those with long half-lives. c) Planet core. Undetectable, possibly non-existent (?). Cosmic origin uncertain. No evidence of life.

I was a crew member on the XLVII interstellar expedition. On the return flight from Betelgeuse, the expedition returned by way of Orn in an attempt to solve the riddle of Ikaros. As a historian and archeologist with no understanding of planetology or cosmogony, I expected to spend my time putting my notes into report form. I was wrong.

The difficulties began when we arrived at the position where we expected to find Ikaros. It wasn't there. The scientists checked their data. There was no mistake. Only when the ship moved

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closer to the double star did we discover Ikaros. Or, rather, what remained of it: a swarm of planetoids and scattered debris.

A shudder of horror swept through the ship. . . . But I will not go on in this vein. I want to keep this report short and factual, to record exactly what we discovered. I do not believe a historian should dramatize his work. Let others write ballads and tragic dramas. I cannot do this, nor will I.

We investigated the fragments. The XXXII Interstellar Expedition had found no trace of habitation. We discovered their error. Only the surface of the planet was uninhabited. Our inspection of the debris revealed, after long study, the following facts and inferences.

Ikaros was hollow, like a gigantic soap bubble. The massive rock casing was only 640 km thick. The space beneath, 10,400 km in diameter, had been filled with highly compressed gases composed of nitrogen, oxygen, carbon dioxide, and heavy rare gases. The physical scientists in our crew believed that the high pressure of the inner atmosphere helped stabilize the relatively thin crust.

In this cavity, in a darkness we would have found impenetrable, in almost complete weightlessness, lived the Ikarians, the masters of their planet. From the hieroglyphics discovered among the debris, it was clear that they were endowed with reason. Although there are no gravitational forces inside a hollow sphere, their sum totaling zero, the Ikarians lived close to their planet's shell where the slow rotation of their world gave a semblance of gravity diminishing toward the poles; there the plants grew that drew their energy from the radiation in the rock, and the Ikarians took their nourishment from the plants.

The devastation from the breakup of Ikaros was nearly total but a few Ikarian bodies were discovered, possibly protected by their surroundings. They were pear-shaped and up to five meters long. The pointed end of their bodies carried what appeared to be a mouth and what appeared to be sensory organs, but only two had purposes with which we were familiar. The Ikarians had four eyes, which were sensitive to infrared radiation; another organ reacted to high-frequency electromagnetic waves. Our scientists believed that the Ikarians perceived gamma rays but, if they did, no sense organ was located. Around the pointed end, as well, were grouped four pairs of tentacles, up to two meters long; each tentacle was split at the end, making it suitable for grasping and manipulation. On the other end of the body were four longer, more powerful, and broader tentacles, with which the Ikarians apparently paddled their way through the thick atmosphere.

Our scientists have been unable to make any conjectures about the civilization and history of the Ikarians. Even if we were able to decipher any of the inscrutable markings on the fragments of rock we have discovered, we could not understand them. Their science was two-dimensional. They must have had extensive knowledge about the topography of the inside of their planet, some aspects of mathematics, mineralogy, botany, genetics, and perhaps a smattering of other sciences. But astronomy, cosmology, even most of physics were beyond their ken.

Their civilization was fundamentally alien. They had neither fire nor the wheel. The Ikarians must have had a feeling for space and time entirely different from humans, who feel the force of gravity every moment of their lives and who measure them out by the rotation of their planet and the movement of their moon around the planet and their planet around the sun.

The technology of the Ikarians was primitive, but they mastered botany, demonstrating extraordinary abilities to exploit the limited energy available. The low level of energy and therefore of nourishment must have been the greatest obstacle to the development of Ikarian

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civilization. Since only a few bodies were found, all Ikarian, they must have eliminated all other animals in order to rid themselves of competition for food. Since the number of plant species discovered was very small, they must have destroyed every other kind, chosen the hardiest and most productive of what was left, and cultivated it in the places where the radioactivity was sufficient. Still, there must have been struggles for survival, and only a strict organization, encompassing the entire inner sphere, could control food distribution and population in such a way as to provide everyone with what they needed. Our scientists have not been able to determine how the Ikarians reproduced, but there must have been a mechanism—biological or social—to hold the population to certain limits. All of these must have come early in Ikarian existence, because there was no evidence of war. That is all we know about the Ikarians, and all we are ever likely to know for certain. We can guess that the planet, in spite of all organization, could have provided food for, at most, one to two million Ikarians dispersed across the entire inner surface; from the equal dispersal of hieroglyphs across the inner surface, these numbers must have been maintained for some thousands of our years. The small excess remaining to the Ikarian civilization in its constant struggle against starvation seems to have been concentrated for some millennia on a single project whose character, despite its obvious immense significance to them, remains obscure.

Concerning the reasons for the destruction of Ikaros, we can only guess. How such a planet could develop is difficult to imagine. Ikaros may have been an artifact rather than a natural occurence, built by an advanced civilization for the Ikarians or for a more primitive form of the advanced aliens and then forgotten. Or if the ancestors of the Ikarians constructed it to escape some celestial danger or to increase their living space, they must have lost their technical abilities and their memory of the past, like albino frogs trapped in caverns who have lost the ability to see. But it is clear that the world was unstable. A relatively small blow might shatter it. Our scientists speculate that a planetoid, or perhaps a body from interstellar space, collided with Ikaros, penetrating the outer shell and releasing the inner atmosphere in a terrible explosion. The shell, unsupported, collapsed upon itself.

But in the sleeptime, while I was considering the plight of the Ikarians, another possibility occurred to me, and I cannot rid myself of it, no matter how hard I try.

That strange enterprise on which the Ikarians worked for thousands of years, their tentacles interweaving, without technology but with all the forces available to them, leaves me no peace.

I have said they were alien, but perhaps they were not *so* different from us. . . . If we were to live in a hollow sphere—for thousands of years, for millions of years—in a hollow sphere that our ancestors had thoroughly explored, had studied until they knew everything about it, and if then one of us came upon the idea, contrary to every experience, that our world perhaps was not the entire universe, that the rocky sphere that enclosed us might have an end and that beyond it might exist yet something else—what would we do?

But perhaps the scientists are right; perhaps my sleeptime terror is only a typical nightmare. Besides, if nothing can change the outcome, why do I hope that I am wrong?■

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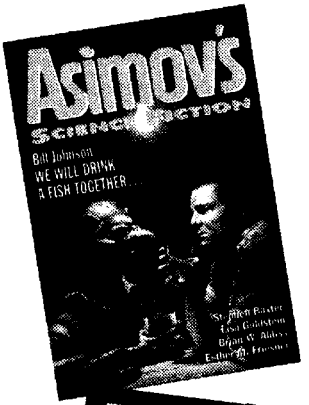

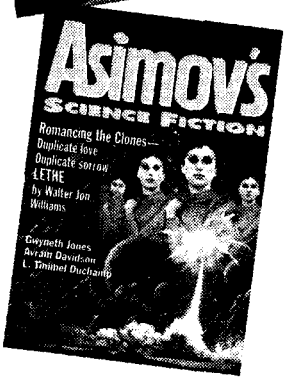

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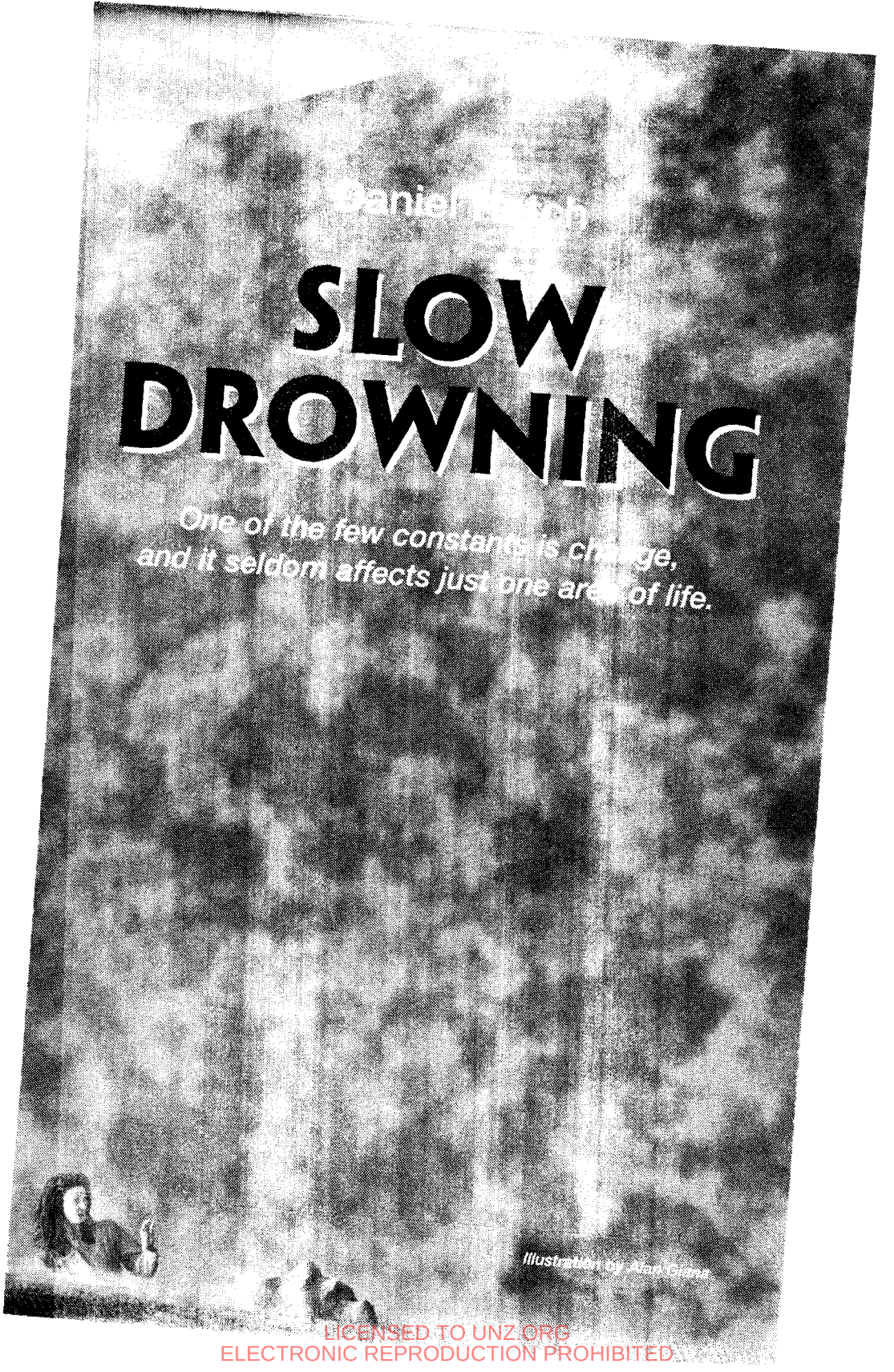
Daniel Walsh
SLOW DROWNING
One of the few constants is change,
and it seldom affects just one area of life.
Illustration by Alan Giana

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Transcript of videotaped interviews conducted under the Living History Project of the City University of Upper New York, beginning in 2012 under a grant from the Vermilion Investment Syndicate. Subject: John P. Russo: born New York, N.Y., April 23, 2013 C.E. (Christian Era), 33 years B.F. (Before the Flood).

The first thing I remember about the Flood was the night I met Peter Kelly.

It was in the holding tank in the Crypt up in East Harlem. It was mid-January and after midnight, but when I got his call, I had to go. It was one of those things lawyers have to do, even when they work for the richest man in Manhattan. So I dragged myself down to the garage, warmed up the Roadster, and tooled up the East River Drive to bail him out.

The Crypt was a big pile of concrete and razor wire they plopped down in the middle of forty or fifty blocks of city that was wiped out in the gang wars. That was a long time ago, though, and now it was mainly a holding tank for drunks, hookers, and kids out after curfew.

Peter was under eighteen, which was what got him a curfew charge, but he looked more like forty when I first saw him. He'd shaved his forehead back a few inches, to imitate male pattern baldness. It was something the boys his age were doing that year. And he still had the nerve to make a remark about the way *I* looked.

"Does Grampa Charlie pay you extra to dress like the guest of honor at a wake?"

I shook my head at his rudeness, then matched him: "No, he pays me extra to come out in the middle of the night to pull ungrateful little imps like you out of the lockup. Dressing like this just makes it easier to get the job done. So be nice, I'm doing you a favor."

"Sorry," he said, slumping down on the plastic bench as if he almost meant it.

"And you're a great one to talk. You look like something that got left in a dumpster. And how come you want to look bald before your time? It won't be that long before you start missing what hair you've got left."

"Do you like this coat?" he asked with sudden enthusiasm. "It's a genuine artifact. It was designed just for the homelies back in the '90s. A bunch of textile students in Philadelphia went out and interviewed the guys sleeping on the street next door and made this from their suggestions. Look—it's got big pockets to carry all your stuff, it's rugged and warm, you can tuck your feet into the flaps at night, and it's a nice dull color, like urban camouflage, so you can blend into the environment."

"And yet, you still managed to get yourself popped," I said. "Curfew violation and trespassing. This is what, the fourth time? Fifth?"

"Sixth," he said sheepishly. "But it's not my fault. We were trapped. The subway flooded."

"That's what the police report said. You got stuck in some room under Times Square?"

"It wasn't exactly Times Square. We were a lot further downtown. You ever been down under? There's a whole world down there—rooms and tunnels and caves. Prime homely turf. Back in the 20th, they made little towns down there. Shacks and shanties and condos with electricity and TV and everything."

"I see. And that all helps you re-create the original experience?"

"You got it, uncle."

"What is it with you kids? I can understand the funny haircuts. Kids always have to wear funny haircuts so they don't look like their parents. But how come you have to run around down in some dirty, rat-infested basement to have fun? Why don't you join a chain gang and watch the kids in California go skin-diving? Or just go out and cop a beer on the roof?"

"You wouldn't understand," the kid

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said. "It's like being contrary, you know? You don't really understand it until you do it, and then you know how it feels and you don't have to explain."

"Sort of like being a Catholic?"

He laughed. "I wouldn't know, but it might be like that."

"That I can understand. Sometimes you just have to do crazy things. But almost getting yourself drowned in a subway tunnel is too crazy. You'll get your Grampa Charlie worried."

"Ah, he's not worried about anything since he had the stroke. And my folks could care less, or else I would have called them instead of you. Anyway, that's the part I still can't figure out."

"What's that?"

"How come that tunnel flooded? It never did that before. It didn't even *look* wet when we first found it. And it wasn't just that tunnel. They said the lines to Brooklyn were shut down. The story is that there was a big storm off the coast and it was high tide, but I don't buy it."

"Why not?"

"Because we checked it out on the city maps on the cablenet and that part of town under just isn't that far down."

I couldn't give him an answer then, and I just shrugged. But a few days later, it would make perfect sense to me. I paid his ticket and escorted him out the door.

"Can I give you a lift?" I asked when we got out into the sharp night air.

"Sure. You're heading downtown? Could you drop me off in midtown. Say Central Park South."

"Why? If you want to panhandle, Times Square is better."

"No, I just want to take a walk in the park and clear my head. Don't worry, my homely coat will keep me warm."

"Suit yourself."

We rode downtown in my big lawyermobile—a '45 Brickyard Roadster about ten feet wide with a steel body and an eight-cylinder engine.

"Nice car," Kelly said.

"Thanks," I replied, indulging in a moment of selfish pride. After my wife left me, that car was my biggest joy. You don't know what it's like to ride through the streets of Manhattan in a car like that.

We turned onto Fifth Avenue and cruised downtown past the dark, empty blocks north of the park.

"People think they know the city if they take cabs and subways, but they don't," I said, taking advantage of my captive audience. "Until you've taken the scale of the place by hand and foot and found how each neighborhood blends into the next, you don't."

"This must have cost you a lot," he said.

"It's worth every penny. There's nothing in the world that can compare with the sense of authority you get from rolling past block after block of the city like this, with the crisp mid-winter air, the lights sparkling all around you, the biggest guy in the biggest car on the biggest streets in the biggest city on earth."

"Yeah, but you know what?" the kid replied. "In a couple of days, you could lose it all. You just never know."

The way he it said left an awful chill in the middle of my back, like he was right and I knew it. Like he knew that every time I got a new toy like the car, I was always a little disappointed that having things wasn't as satisfying as getting them.

And as it turned out, he was right. A couple of days later, that thrill was gone and I never could get it back.

I slept late the next morning and worked at home.

I had the kind of home where you could do that. It was a ten-room suite in the old Stock Exchange, down on Wall Street, the one with the big stone columns in front. Besides the bedrooms and kitchen and living room, it had a fully equipped office with law library, a conference room with the full electronic outfit, and a wet bar the size of Halloran's next to City Hall.

That morning, I was working on the

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income taxes for Quasar Econometrics. The Feds got rid of the national income tax before I was born, but New York State and New York City continued their best efforts to share the wealth. And even though they were simpler than the crazy days of the 20th, they were still a pain. I had to review everything because Quasar was one of Charlie Longstreet's babies. Everyone knows him for creating Vermilion, the first computerized investment syndicate, but what made those syndicates work was the supercomputers that plotted their investments. And Quasar was Charlie's.

So I took special care going over it to make sure things were right. The real experts on tax law are the accountants, of course, and they'd done everything right. But Charlie didn't need to spend his time making sure—that's what he paid me for. I guess when you get past ninety, you're allowed to slack off.

I knocked off after a couple of hours to make my regular Wednesday lunch date. This week, it was at an Indonesian restaurant over in Battery Park City that had a great rijstaffel. I called a cab—you can never find a place to park during the day downtown—and met the rest of the group at the door.

"Hey, Johnny, how many billion did you guys steal from us today?" Gus Karmanos asked when I walked up. Gus was head attorney for Chartreuse, second only to Vermilion in assets. With Gus were Anne Pritchett, a partner with Goodman, Smith, Thompson, and Black, and one of the firm's associates, a fresh-looking kid in a suit that still crinkled when he walked. We were about to go in when Anne pointed out a man at the door.

"That's Rennie D'Amour," she said. "He's clerking for Judge Santos over on the federal bench. He used to work for us before he moved over there. We should ask him to eat with us."

I shrugged. I wondered if maybe she wanted someone else at the table as young as her pet associate, since Rennie was clearly only a couple years out of law school. So we invited him along, changed our reservation to a larger party, filled our plates with the rijstaffel, which is kind of a buffet with combinations of Dutch and East Asian cooking, and discussed the premier of "My Three Sons" up at the Regency Theater. When we were done and the coffee was served, I asked Rennie D'Amour the inevitable question.

"So Mr. D'Amour, why did you decide to clerk for a federal judge? Is this some kind of work-avoidance scheme?"

D'Amour laughed nervously, but didn't seem to relish the joke. "Actually you'd be surprised. It's really very challenging. When they stripped the federal courts of jurisdiction of all the so-called trivial issues back at the turn of the century, only the most important cases were left for them to decide. In fact, you might want to tune in to the federal monitor this afternoon," he said. "There's a really interesting one coming up."

"An interesting federal case?" Gus asked. "I thought they outlawed those when they started impeaching activist judges."

"Well, the state court didn't want to handle it," Rennie said. "They couldn't agree on jurisdiction. And by rights, it is a federal case."

"What kind of case?" I asked.

"Proprietary information," Rennie said. "Plaintiff is the federal government. Defendant is a small research company, Amundsen Projects of New York City. Plaintiff wants access to defendant's databanks. Defendant says they have to wait until cleared by corporate management up the line—and the defendant's owners are delaying release."

"What's their reason?"

"Public interest, of course. It's a strange argument to make, I know, like something out of the 20th century. But it's not unprecedented."

Anne grinned, looking feral and predatory, like she'd just caught the scent of something warm, furry, and

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slow. "Who's the corporate higher-up?" she asked.

"Chartreuse On-Line Investments," he said.

"Woops," Gus spouted, setting his coffee down so fast that it spilled onto the table. "I probably shouldn't be sitting here much longer. This has conflict of interest written all over it. You'll have to excuse me. Johnny, give me a call later and you can tell me what everyone said."

He was up and heading for the door so fast you'd think he'd heard an ambulance go by, but he didn't miss anything. D'Amour had exhausted his store of unprivileged information and the conversation quickly moved on to internal politics at Goodman, Smith, Thompson, and Black.

I was rescued from near boredom by the waiter.

"Sir, the gentleman at the table in the corner would like to speak with you."

I looked where he was pointing and saw that the "gentleman" was the restaurant's crash dummy, one of those VR mannequins that were a lot more popular ten years earlier. I threaded my way through the tables and set myself down in the dummy's field of view. This was a good one, with two fully articulated arms and hands and a fairly lifelike plastic face. It didn't have much expression, but whoever was at the other end could do more than see and hear all that went on at the table, he could also pick up a drink and gesture and even flirt with his date.

I had a feeling who was at the other end of this crash dummy, and I was right. It was my boss, Charlie Longstreet.

"Hi, Johnny," he said. "I hope I didn't interrupt your meal."

"No, sir," I replied. "We were already finished."

"Good. Now what can you tell me about a federal case that's supposed to open this afternoon? Some kind of motion to disclose proprietary information?"

"U.S. versus Amundsen Projects, a small research company owned by Chartreuse. The government wants them to release information in the public interest. Amundsen says they have to wait until Chartreuse approves it. Chartreuse is taking its own sweet time with the approval."

"Boy, I love it when I get my money's worth," Charlie said. "How do you do it?"

"You just have to have contacts in all the right places," I said. I wasn't about to tell him the real story if my life depended on it.

"I guess so," he said. "Anyway, I want you to sit in on it. There's something big going on here. I can smell it. Call me back as soon as you get out and we'll figure out what to do from there."

"Yes, sir," I said.

"And tell Anne Pritchett that if I were thirty years younger, I'd be there in person just so I could sit across the table from the most beautiful lawyer in Manhattan."

"If I told her that, she wouldn't believe me for a minute. I'm afraid it's an occupational hazard of attorneys—everyone thinks you're lying. And besides, if word got out that you were dining with Anne Pritchett, your family would start to wonder about your stroke."

"I guess we wouldn't want that, would we? It's just that this charade keeps me from visiting some of my favorite places. At least in the flesh."

"When we get a minute, I'll tell you stories."

Foley Square was one of Manhattan's little surprises. Most people don't realize how close things are downtown. They don't know that police headquarters is a block over from City Hall, and the courthouses are another block uptown. You just head towards the municipal building—that's the really high one with the huge free-standing colonnade in front and the big arch in the middle—and

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then turn left. Down the hill you'll find a wide open space with not one, but two massive courthouses standing side by side, stony-faced, lined with steps and columns, topped by classical capitals: the state court, slightly more ornate, on the left, and what used to be the federal court on the right. The state took over that one before I was born, but the Feds still used space in the back.

Despite the video monitors, courts are still pretty resistant to modern technology. Judges like to do things up close and personal, face-to-face. None of this virtual courtroom stuff they've been predicting since I was a kid. Maybe they want to be able to order the bailiff to lock someone up if they don't like his attitude. It's hard to do that over the screen.

It means a lot of running around for lawyers, who would rather phone it in, but it maintained a certain sense of solemnity and seriousness. So when Judge Santos convened the District Court, I paid my due respects and showed up in person, finding an empty bench in the back to fill up. I smiled at Rennie D'Amour when I caught his eye, but he kept a serious face. The poor kid was probably working twelve hours a day and didn't have much to smile about.

Santos didn't let things get much beyond "All rise, the honorable Judge Herbert P. Santospresidingallthosewithbiznizmizsupbefore the court." He began by questioning Fernand Kachoubian, chief operating officer of Amundsen Projects.

"Mr. Kachoubian, can you tell me why you don't want to release the information the government is asking you to?"

"Yes, your honor. I've been told not to by the owners of Amundsen Projects."

"And what would happen if I told you right now to tell me what you won't tell the government?"

Kachoubian swallowed hard and turned pale. "If I did, I'd probably be fired, your honor."

"Your honor, if I may point out—" the Amundsen lawyer started to say.

"No, counselor, you may not point out," Judge Santos said. "Fired, Mr. Kachoubian? That would be awful, wouldn't it? Much worse than what I'm going to do to you."

"Your honor?"

"Mr. Kachoubian, I'm going to find you in contempt. You never should have come here today pretending you are free to carry out my orders. I don't want to deal with people who can get fired, I want to deal with the people who do the firing. You can spend the night in jail and come back here tomorrow with whoever owns Amundsen Projects and let them explain to me why they shouldn't do the same."

"But your honor . . ." Kachoubian stammered.

"Case recessed until tomorrow at 2 P.M.," Santos said as he stood up. Everyone followed suit, and the bailiff said, "All rise," and the judge was out of the room. So was I. A few minutes later, I was on the phone to Charlie Longstreet.

"Well ain't this a barrel of laughs," he said. "Poor Chartreuse has got a federal judge on their backs. You know what we should do, Johnny?"

I was afraid to guess, though I had an idea in mind.

"We should buy that sucker away from them."

That turned out to be easier said than done. I found out real fast that Amundsen was not a public corporation, but a wholly-owned subsidiary of Chartreuse. And that meant we had no leverage over it.

We couldn't buy up the stock under third-party arrangements and then transfer ownership to Vermilion, which was the usual way of doing such things. We couldn't do much more than call up Gus Karmanos and ask him if he wanted to sell, because the company couldn't change hands unless Chartreuse agreed to it.

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Charlie took the news calmly.

"Johnny, you're thinking too small," he said, leaving me to wonder how much bigger he was thinking. "There's more than one way to make an omelet. If we can't buy Amundsen, then we have to aim higher."

"Higher? You're not really suggesting that we try to stage a hostile takeover of Chartreuse, are you?"

"I'm not? I sure thought I was. You've got all night."

I cringed. "Be realistic, boss. We may be twice their size in assets, but that doesn't mean we can pull off something like this. Certainly not overnight."

"Why not?"

"It's never been done before."

"Until now. Look into it and see if it can be done. Then let me know."

So I went home, and poured myself a drink. And after a few minutes, when I finally could relax, I called Quasar Econometrics. Charlie had started the company with a couple hundred thousand dollars worth of personal computers linked into a homemade supercomputer and a dozen smart kids who'd dropped out of Princeton. Now they all wore suits more expensive than mine, and Quasar had real supercomputers linked into a homemade megacomputer. And that megacomputer was what made the whole thing possible.

I told them what the problem was, and they linked me up to the artificial intelligence interface. "Mirror, mirror, on the wall," the bodiless face murmured as it swam into being on my wallscreen. "Your wish is our command."

The face wore a turban with a jewel in it, some idea of Charlie's that had to do with his baby boomer childhood. "I want to buy Chartreuse On-Line Investments by tomorrow morning," I said.

"Any limitations on risk to Vermilion?"

"Let's bargain the risk as we go along," I said.

"My kind of operator," the face said with a smile.

We ran through decision trees for a while, with the face asking me a series of questions to set the limits on its simulation. Then we started the bargaining. At zero risk, there was no chance of buying our chief rival before the end of the year. We couldn't even get it into January without a thirty-two percent chance of losing our shorts.

Each time we brought the time frame down, the AI reran all its projections, working through all the moves that we could make and all the countermoves that Chartreuse could make, like one of those horrible chess engines that used to chew up players left and right in the tournaments.

"Stop messing around and bring this thing up to the real deadline," I said after a while.

"In a jiffy," the face said. A moment later, it spun once around and announced: "A forty percent chance of losing all your assets if you try to do it by noon. Forty-five percent by eleven o'clock. Fifty percent by ten."

I sighed, then called Charlie.

"You know how I made my fortune, don't you?" he asked. Of course I knew. He bought the winning ticket in one of those huge lotteries back at the turn of the century. "The odds then were a lot worse than fifty-fifty. Go for it."

"Charlie, do you know something you're not telling me about Amundsen Projects? It seems like an awfully small prize to risk everything for."

"I always know something I'm not telling you," he said. "It's usually for your own good."

"I'm not so sure about that," I said as he broke off the connection.

"Go Vermilion, make a billion."

That was the slogan that built our empire. Every day, more than thirty million people all over the world did business with us, instantly, from anywhere on the planet, over the cablenet, by satellite, even by telephone and paper mail. They paid their bills with us, invested with us, gambled with us, consulted us about the

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likely future of the stocks, bonds, and the economy, and generally treated us like partners in their financial lives. It was a tremendous responsibility. And a tremendous power.

The computer investment syndicates like Vermilion and Chartreuse and a dozen or so smaller competitors were a combination of several 20th century institutions—stock brokers, mutual funds, insurance companies, health maintenance organizations, credit unions, and banks. They were the culmination of a number of trends—the democratization of the stock market, the rise of the personal computer, and the deregulation of finance in the global economy of the 21st.

That was where I came into the picture. One by one, barriers to swift and integrated computer delivery of financial and other services had fallen. I argued the case against letting the New York State Securities Commission regulate us. It wasn't hard to do. I just pointed out that all the other obstacles were already gone, and there was no point in keeping the last one up when there were so many ways around it.

I guess Charlie was impressed, because that's when he made me his personal attorney—and chief gopher.

It was a marvel to see these big combines in action. That night, I got to see plenty. Nothing like it had ever happened before. We started the operation at six o'clock. In some ways it resembled a leveraged buyout. That's when you borrow against the company you're going to purchase to buy their stock. But Chartreuse didn't have stockholders so much as it had subscribers, so we had to lure them away with more than just a few dollars. We had to offer them all the things they were getting from Chartreuse and more. And we had to make it part of a conversion offer that gave us their membership in Chartreuse in return for a new membership in Vermilion.

If the offer were for a fixed sum, it wouldn't make much of a splash. People could calculate the advantage, wait us out, see if we upped the ante. With a noon deadline, we didn't dare take that chance. So we gave them an offer that was more than generous, more than magnanimous, more than rational. We gave them an offer that was truly insane. Ten times as much money as the subscriptions were worth.

And then we put a time limit on it. As the night went on, the offer would go down. The Quasar megacomputer kept a running tally of where we stood, determined the size of the remaining market that we needed to attract, and set the price accordingly. The idea was to bring over the smallest players first, keeping the aggregate cost for them low. Those with bigger shares in Chartreuse would move more slowly, waiting until later in the evening, when their subscriptions would be worth less proportionately, but would still bring in a sizable bonus. When the really big players, the institutional investors, made their move in the morning, they'd be working with a small but healthy margin of profit for themselves.

We started with a general release of the offer. That meant gigabytes upon gigabytes of spam pumped into the cablenet. And personal phone pages to every Chartreuse subscriber we could identify. And press releases to the news networks. By seven o'clock, there wasn't a soul on the planet with spare change in his pocket who hadn't heard of our offer.

I could almost imagine the word spreading, sweeping over the nightclubs in Paris and London, over dinners in Manhattan restaurants, splashing from Chicago to Denver to L.A., catching Tokyo as it was rising, stirring Beijing and Bombay from a sound sleep, rousing the Arabs and the Africans from their beds.

Then I realized I didn't have to imagine it. When I was a teenager, I was quite a chain-ganger. We didn't have any specialized software then, just a wall

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screen and a few terabytes of RAM. We still split the screen, split it again, and again, until we had dozens of kids all linked to one leader—the one with the full virtual audio-video rig who actually did things while the rest of us watched.

Well that night I used the latest chainer app to link to all the places where people were talking about the Vermilion offer. Park Avenue coffee shops full of retirees dressed in black, Chicago's commodity exchange, L.A. lounges and exercise shops, geishas in Tokyo, mah jong parlors in Beijing, teahouses in Dhahran. Everyone was talking about it. Everyone wondered if they should get in on it. They debated the risks—if it failed, everyone who bought in with us could end up broke. And they speculated on the benefits—if they just moved fast enough, they could make a killing overnight.

And I watched and heard it all. Hundreds of people, thousands of voices, a whole world enthralled by a feat of financial acrobatics, a whole world caught in a great web of money and obligations and speculation. I was amazed. For the first time in my life, I had a sense of the immense scope and range of the power that Vermilion maintained.

I stayed up all night, watching as Quasar's face in the mirror kept track of our progress. We had a nervous couple of hours between two and four—the U.S. and Europe were fast asleep and the big numbers of earlier on dwindled quickly. But things picked up with the sunrise.

In the end, I was caught by surprise. Just before eight, as the sun came spilling in through the living room windows, Quasar's AI announced the results.

"Sir, we have been successful. We now have a controlling interest in Chartreuse On-Line Investments."

"So early? I thought we were shooting for noon."

"Yes, sir, but we overestimated their ability to fight back. They did none of the things we anticipated. They didn't even issue a press release. They just sat there and took it."

I let out a yell, then stood a while in the window, soaking up the sunshine, looking out at the people filling the sidewalks below as they faced a brand new day in a brand new world.

I'd done it. I'd pulled off the biggest takeover in history in record time.

And to this day, I don't think more than a handful of people know that it was all to get our hands on a nondescript scientific research company no one had ever heard of before.

The first time I met Charlie Longstreet, it was in his room at the Keith Richards Life Extension Institute up near the Rockefeller Mansion in Duchess County. I walked in and found a small man with a long white ponytail making soft moaning sounds. I panicked and was about to call for a nurse when he opened his eyes, appeared startled, then pulled off his headphones.

"I'm sorry. That must have sounded awful," he said. "It's been a long time since I could really sing along with the Stones."

"The Stones?"

"You know, the Rolling Stones. Mick Jagger. Keith Richards. Jeez, they must have banned them before you were born."

He hadn't changed much since that day. His hair was still white, long in the back and tied in a ponytail. His skin was thin and almost transparent, mottled with liver spots and moles. His face was a network of wrinkles, mostly from smiling too much.

I was exhausted. Instead of sleeping, I'd taken a shower, downed two cups of coffee, and driven the Roadster up the Major Deegan and beyond to meet the boss. He wouldn't tell me what it was about, only that he'd seen what Chartreuse was trying to keep secret and he knew why it was so easy to buy them out.

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"We've really screwed the pooch this time," he said.

"And what did we do wrong?" I asked. "And who do you mean by we?"

"I mean all of us," he said. I relaxed. I thought he was talking about something I did during the night. "The human race. Every last one of us."

"And what did we do?"

"We screwed up the planet real good this time. And there's no way we're going to fix it. Johnnie, the ice caps are melting."

In my fatigued state, I wondered if I were having an odd dream. My mind was blank and my emotions empty from lack of sleep. So the meaning of his statement didn't really sink in.

"As in?" I asked.

"As in the ice caps are melting and the sea level is rising and it's too late to do anything about it."

"The ice caps? Both of them?"

"Antarctica, to be specific. That's what Amundsen and Chartreuse were keeping secret. You know, before you were born people were afraid of global warming. The prophets of doom said it would melt the ice caps and ruin the ecology. That was before we got Virginia orange juice and palm trees in Atlantic City and cotton in Iowa and the powers that be made a virtue out of negligence."

"Antarctica? How much ice is there down there?"

"How much? That's the question. According to the reports, the scientists used to be afraid that West Antarctica was the threat. They figured if that slipped into the sea, the oceans would rise ten or twenty feet. But what's happening is something entirely different. We're losing the East Antarctica ice sheet. The whole thing is slipping off the continent."

"I see," I said calmly, the fatigue deadening the impact of the most dreadful news the planet had ever heard. "So how fast is this happening? Continents are big things, aren't they? It should take an awful long time."

"They're not big enough," Charlie said. "Amundsen says the glaciers are surging. They say it happened before, back between ice ages. They've tracked the gravel from melting ice bergs across the ocean floor."

"All right. How long is this going to take and how bad is it going to get? What's the bottom line, Charlie?"

"They say the sea level could go up fifteen feet by this time next year. And another fifteen feet next year if it keeps up the pace. It could go on for years, they say."

"Years? How many?"

"Ten? Twenty? Thirty? Who knows? They say that after thirty-five years, all the ice down there will be in the drink, so I guess that's the outer limit."

"Thirty-five years? Good lord, Charlie, that's over five hundred feet," I was still struggling to appreciate the gravity of the situation. "How far inland do we have to go to get away from the flood?"

"The Poconos," Charlie said. "The Catskills. Everything else will be gone."

"The Catskills? Thirty-five years?"

"Don't look so glum, Johnny. We've got time. You'll be able to take care of things. You know what I mean, don't you?"

"Take care of things?"

"Yes, Johnny. Take care of things. This is going to shake the world up and fast. I've spent my life building up Vermilion and all the rest. You've got to take care of it. Protect my investments. Make sure that Vermilion makes it through this. Johnny, I'm counting on you to save my fortune."

The surrealism of the day was not over.

Before I could sleep, I had to make an appearance in court before Judge Santos. The ride back down into the city was tough. With the autopilot on, I had trouble staying awake. Every time the road dipped down an incline, I'd have visions of driving into the water, vivid enough to be real or a dream. It kept my

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adrenaline flowing, though, and kept me awake all the way to Manhattan.

Seeing the expression on the face of Gus Karmanos when I stood up to represent the new owners of Amundsen Projects made the trip worth it. He sputtered and fumed at being ordered down here by his new employer, then reddened at the sight of me.

"Your honor, I would like to settle this whole thing right now," I said. "I represent the Vermilion Investment Syndicate, and since eight o'clock this morning we are the new owners of Chartreuse On-Line Investments. That makes us the new owners of Amundsen Projects. Prior to entering the courtroom this afternoon, I ordered the company to comply with any and all requests from the U.S. government to release information that it deems to be in the public interest."

"Counselor, you've made my day," the judge said. "Case dismissed."

"Is this what you did it for?" Gus asked.

I said nothing, but he took that as assent.

"But why? You swallowed your biggest rival, spent millions, maybe billions, just to get your hands on this little two-bit science shop? It doesn't make sense."

"We were worried about buying beachfront property," I said with a smile.

He sputtered and stammered some more, but had nothing to say. And I realized that he hadn't been told about the iceaps, or he would have known why we did it.

I finally got home and went to bed, sleeping through the evening and into the night. The next morning, as the calls backed up on my service, the truth began to set in, cold and overwhelming, like the rising sea itself.

The first message was from my wife. She never called anymore, so I knew it was serious. "I know I'm a very demanding woman," she said. "But I'm sorry to make so many demands on you. Just tell me one thing. Is this for real? Because if it is, I want a new house. Up in the hills, above the water. Call me right away, sweetheart."

I made a mental note to do just that, then I threw it away. It was marriages like ours that made legalizing divorce again sound like a good idea.

The next call was from my mother. "Johnny, I'm so worried. Your father says we're going to have to move out of the city. Where would we go? Long Island isn't going to be safe, they say. And there isn't even going to be a Florida anymore. What are we going to do about our retirement property?"

I didn't know what to tell her. I felt helpless.

And that moment of helplessness drove home for the first time just how bad the news was. I struck me that a disaster that takes years to unfold consists of just those little problems that hit us where we least expect it and become major personal crises. It was like being told you were dying of some incurable disease, but it would take a decade or more to happen. It undermined every dream, every hope, every expectation.

There were many more calls from reporters, vendors, salesmen, entrepreneurs, and Vermilion First-Class members looking for advice, information, or a deal. I referred all those to Vermilion staff. I wasn't up to dealing with any of them yet.

And there was a message from Charlie's great-grandson, Peter Kelly.

"I said you could just lose it all. Was I right or what?"

The thing that surprised me when the word got out was the lack of panic.

I suspect a lot of things were behind that. For one thing, we'd long since grown too self-involved to recognize a natural disaster of any proportions that didn't affect us personally. You could see them on the screen whenever you

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wanted to—fires in L.A., plagues in Africa, famines in Asia, rivers overflowing their banks in the Midwest—but none of them really mattered. And we'd long since become accustomed to the effects of global warming. This was just one more in a long series, like big hurricanes, summer floods, and tornados in New England. It was a little bit extreme, but in the same line. We would adjust.

And people were very good at rationalizing the story away. "Whadda those scientists know, anyway?" they said. "You can't melt that much ice, it would take too much heat. And glaciers don't move that fast. It'll take hundreds of years before the ocean rises."

But I lacked the luxury of ignorance. I'd read the reports. The ice wasn't melting, it was just slipping off. That took a lot less heat. And glaciers did too move that fast. More than ten feet per hour. I could just imagine it—ten feet per hour is two inches per minute. Barely enough to see. Keep it up for ten years and you move 165 miles. It's almost as bad as compound interest.

At first, there were no immediate signs that anything was happening.

The South Atlantic was filling up with icebergs. That was what drew everyone's attention to Amundsen Projects in the first place. After the Feds were downsized to a shoestring, they bailed out of scientific research, including Antarctica. Amundsen was a contract research firm that kept an eye on the frozen continent by satellite and remote sensor. They'd picked up the signs of something unusual back in October. Just a steady increase in the temperature, up maybe five degrees above normal. But far too many days out of the year, normal temperatures down there were in the balmy twenties .

Too much ice in the ocean was a problem for oil tankers and fishing fleets, however, and not for New Yorkers worried about not enough ice in their drinks.

With the normal tides in New York Harbor running about six feet up and down, it would be a while before low tide was up where high tide should be. And until then, flooding would be incidental and inconvenient, not catastrophic.

It wasn't until March that the Holland Tunnel first flooded. And that was when a late winter storm pushed too much water up the Hudson at high tide. They put the yellow barriers around the roads and waited for the water to go down. It did—for a while. Either way, it didn't bother me. I hardly ever drove over to Jersey.

Battery Park wasn't fun to visit anymore. The sidewalks were always getting covered with the worst that the Hudson had to offer at high tide, and in the spring the grass didn't grow and the flowers didn't bloom.

The Holland flooded again in April. The barriers went up again, but when they stayed up for a week, people just accepted that they wouldn't be coming down. The subways downtown quit about the same time. That was more of a shock, but the Transit Authority just added buses to Broadway and shuttled people south from Greenwich Village.

Bellevue Hospital had some problems when the water filled its basements. The city called out the whole Public Works Department one day to start putting sandbags around the place to keep the East River out. The difference between Bellevue and the Holland Tunnel was that there were a lot of people in Bellevue who wouldn't survive the move to a new hospital. And the water wasn't that high yet.

I didn't take the flooding seriously until they closed down the East River Drive. It was such a beautiful stretch of road, winding along the riverbank, under the foundations of big buildings like the United Nations, with a view of Queens across the water. It used to carry me right up Manhattan to anyplace else I wanted to be—Cape Cod, New Hampshire, the Adirondacks, the Catskills. But it dipped too low near

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Bellevue and that was all it took. I had to stick to the city streets whenever I wanted to go for a drive, and it just wasn't the same. Especially with everyone else who had to find alternate routes jamming the pavement along with you.

In May, I ran into Simon Mendelsohn in the deli downstairs at the Exchange, complaining about the water. "I just came back from Miami Beach," he said. "What a disaster. The hotel lobby was a stinking, soggy mess. I'm never going back there again."

He sounded so serious that I had to laugh. I don't think he quite realized that he no longer had that option.

In June, the whole of downtown was invaded. The National Guard, the Army and the Marines, helicopters, hovercraft, and dozens of armored trucks. They descended without warning, swooping in from every direction, convoys rumbling down Broadway in the dead of night.

They rolled to a stop in front of the Federal Reserve Bank a few blocks from my apartment and started loading up the gold. It took them all week. For a few days, it was almost fun watching the normal routine of downtown Manhattan try to work itself around the armed guards, the patrols, and the closed streets. Then they were gone.

With typical New Yorker stubbornness, we picked up where we'd left off and carried on as if they'd never been here. That was the way we treated it all. We made adjustments, curtailed activities, noted the streets that were no longer passable, and found detours around the problems. Denial was always one of our deep-seated traits.

But we weren't ignoring the looming deluge completely. People like me were busier than hell.

Chartreuse had given us a head start on the task that lay before us. The reason they'd been so easy to buy up was that they had overextended themselves trying to prepare for the rising tide. They'd bought everything they could imagine to take advantage of what was coming: fleets of moving vans and heavy equipment; real estate in the high country and the interior; warehouse construction firms; building contractors; anything that might be needed to move anything moveable away from the low ground and to replace anything that wasn't.

Vermilion had deeper pockets than Chartreuse ever did—especially after we cleaned their pockets out, stripped the company of anything useful to pay the price of the takeover, then set it free to rebuild on its own. So we just followed their original battle plan, only with a longer reach and bigger appetite.

Then one day in June, Charlie Longstreet sent me out to Princeton.

At the Holland Tunnel, I mumbled some choice curses that I'd learned from my Italian uncles, then headed the long way around New York Harbor to cross the Verrazano bridge. It was half an hour before I could set the destination, lock in cruise control and radar watch, and relax. I let the city blocks roll past, then the Watchung Mountains—really just a ridge of low hills—then the countryside. I would have enjoyed it more if I didn't keep picturing it as the bottom of a new sea.

It wasn't the university we were interested in, but a private research firm a few miles west of town. I could still see the ivy-covered halls in the distance, though, as I cruised down Route 1, and a flood of old memories rushed back—studying for finals in the dorm, dinner at the eating club, my first real dates after all those chaperoned years at St. Mark's in Manhattan.

Harry Wan had a round face, thick black hair, and Asian eyes, but he was an all-American hard-sell salesman trying to attract capital for his product, rattling off figures and facts faster than I could keep track.

"We've had the best engineers in the country working on this problem for six months," he said.

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"Five," I said, correcting him. He didn't notice.

"And we've covered every possibility. These aren't just designed, they're engineered. And we stand behind every unit."

It was probably a good place to stand, since he was selling dikes. Not just any kind of dike, but the permanent kind. The kind the Dutch used to hold back the sea for centuries—though now even they were losing hope. Each unit was massive, twenty feet wide at the base, six feet wide in cross-section, thirty feet high, and in pieces from thirty to one hundred feet in length.

"We've had consultants from Amsterdam and Eindhoven working with us, proofing our design. And we've been conducting field trials down in Cape May to show just how reliable these things are."

"I'm sure you have," I said. His eager engineer persona kept struggling with his annoying salesman persona to see which would rule. In the process, I grew slightly uneasy about his company's grand design concept.

"And these are all modular. We install them on the spot, to your specifications. Piece by piece. You can cordon off a block, or a dozen blocks, or a whole business district."

"I see. How about the island of Manhattan?"

The steam seemed to run out Harry Wan all at once as the scale of the project hit him in the forehead. The engineer was calculating perimeters and modules, while the salesman was working out marginal return on investment. The two were likely to get into trouble if I didn't intervene.

"And do you have any idea who could pay for it?"

That pretty much put his lights out. I had pulled his imagination out of the virtual world of design computers and business models and into reality. He had that distant stare that was becoming more and more common these days, as the depth of world's predicament become obvious.

"I guess we're talking billions," Harry said. "A hundred-foot module is a million list, and even with discounts we couldn't go much below half that. That means fifty of them per mile times twelve, twenty-four, thirty or forty miles around Manhattan, once you conform to the topography and the street grid. So forty times fifty is a couple thousand. And that makes your billion right there."

"And what do you do when the water keeps rising?"

"You need to double up the base to put the next course on. So two billion in two years, four billion in four, eight billion in six . . ." He ticked off numbers silently on his fingers. ". . .thirty-two billion in ten years . . . you'd hit a trillion megabucks in twenty years."

"An exponential increase in costs from a city that's losing assets, employers, employees, and real estate," I said. "Sounds like a tough sell."

"Yes, it is," Harry said. "We were looking at a smaller-scale operation, to tell the truth."

"You mean like downtown Princeton?"

"That and the university," he said.

I chuckled, but unfairly. Poor Harry Wan. He had a good idea, but still had trouble comprehending the scope of the problem. If the ocean did not stop rising, there was little any of us could do to hold back the water.

I left him my private number and promised I would discuss his dikes with the other movers and shakers in the city, then I got back into the Roadster and cruised back home.

But as the New York skyline came into sight, it occurred to me that Wan's project wasn't as desperate as it seemed at first. It was near sunset by the time I came across Staten Island and lights of Manhattan burned softly gold. By the time I was across Brooklyn, the full scale of their mass hit me. These were mountains of glass and steel and cable and electricity—in their own way every bit

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as strong as the sea. And they rose against the sea like a barricade, ten, twenty, thirty, forty stories high.

"Let the waters rise," I said aloud. "We'll still be here. We may get our feet wet, but our heads are still up there in the clouds."

A week later, I was in Cambridge. Not back at Harvard, but down by the river at M.I.T. Boston was a mess. My traffic-guard warned me that the turnpike was closed at Newton and sent me the long way around on Route 2 into Harvard Square from the northwest. Commonwealth Ave. was lined with sandbags down to the Charles and the whole M.I.T. campus was surrounded by dikes and pumps and fire hoses. I heard on the radio that Back Bay was a mess, with the Fens filling up and spilling over everything at high tide.

At least the engineers were an improvement over poor Harry Wan in Princeton.

"We're not sure what the best application for this is," said Alec McClintock, the grad student who was assigned as business liaison. "From what I understand of it, it's barely technology, almost more like gardening or zoology. But the engineering team says they've done so much to the genes that it's more like writing computer code."

What they had was something that used to be coral, but was now something quite different. It attached itself to structures and covered the surface, producing a substance with the texture and look of coral. But inside were channels and pumps, tiny capillaries connecting to larger and larger tributaries, until they flowed into larger pipes that ended in standard fittings along the top.

"You coat the outside of a building or wall, and it grows, pulling dissolved minerals out of the water. The pumps keep one side dry while the other is holding back the water. The seal is perfect, or nearly so. The pumping efficiency is high. Your building supplies are free. And the whole thing is self-contained."

"If it's that great, why aren't you using it here?"

"We are, on some of the buildings," McClintock said. "But the campus is pretty much in a hopeless position. We were ten feet above mean sea level when the waters started to rise—thirteen feet at the benchmark over there. We don't think we'll have time to anchor the coral properly before the place is awash. Even though we might be able to keep our heads above water, so to speak."

He smiled with an odd eagerness. For the first time, I noticed how young he was, a first-year grad student. His eyes looked old beyond his years, though; even if he didn't shave the top of his head. "You know the ice is going to stop surging long before it runs out, don't you?" he asked abruptly, without prompting.

"Wait, wait, wait," I said quickly. "What's that?"

"I said the glaciers will stop surging and the ocean will stop rising long before the ice runs out down in Antarctica. We've done simulations for a couple of months now. For the moment, the ice has got a lot of inertia. And all kinds of strange things are going on where it meets the bedrock. But after they've run a hundred miles or so, they're going to run out of steam. We figure anywhere from a quarter to a third of the ice cap is going to go. That means sea level won't rise more than one or two hundred feet."

"Only two hundred? I guess we're saved."

"Seriously," he said, "it makes a difference. Five hundred feet means everything back to the Berkshires is at risk. Two hundred means half of New England, big parts of the Eastern Seaboard, some important parts of Western Europe, and much of the southeastern U.S. are all going to stay dry. It's the difference between a tragedy and a catastrophe."

I shook my head, then tried to put it

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all in perspective. Here was a kid who was optimistic that we would only lose Boston and New York, but not Massachusetts and the Mid-Atlantic states. How quickly we had adjusted to the prospect of loss. I had to laugh.

Poor McClintock didn't understand, and that made it even funnier. Before I could stop, I was laughing so hard that I was out of breath and turning red. And I couldn't even explain it to him.

It was a long ride back to New York and after dark when I got there, a late spring thunderstorm was blowing out of Jersey as I rolled down the Major Deegan. The barricade of lights and buildings was reassuring once again, even if it amounted to nothing more than bravado.

Then I started thinking. Two hundred feet was about twenty stories. Less for the buildings on higher ground, like up in Midtown. There were a lot of buildings bigger than that in Manhattan. An awful lot.

And Cambridge Coral looked awfully cheap compared to the trillion-megabuck dikes out in New Jersey.

When Charlie Longstreet first suggested that we fake his incompetence, I tried my best to talk him out of it.

He said he was tired of his family bothering him for money, for favors, for advice, for help, for everything. "They've done it all their lives," he said. "They did it before I got rich. They'll keep doing it long after I'm dead. I just want them to leave me alone."

But that wasn't really the problem. It was his children. They wanted to create an expert program, an artificial intelligence, based on him. They would have spent weeks, maybe months, interviewing and interrogating him, analyzing what he said, then posing endless problems for him to solve until they had the algorithms to mimic his thought processes.

"The only problem is that I don't have any thought processes. I do what makes sense and I don't do what doesn't make sense. There's no special skill or ability to this other than having the money in the first place. And all that means is being patient enough or lucky enough. Someone once told me that all you need to make a fortune is a thousand bucks you can afford to lose and big, brass balls—so you don't chicken out when that thousand has grown to a hundred thousand, because you could afford to lose it in the first place. And I started off with the buck I spent on a lottery ticket."

So he worked on me and worked on me.

I explained to him that the code of ethics does not allow a lawyer to participate in his client's lies. He told me to ignore it. I told him I couldn't. He told me to do it so we didn't have to lie—not officially, in any case. So I came up with a trust for all his assets, including his share of Vermilion and all his personal holdings. That kept it out of the hands of his family as long as he was alive and when he died, much of it would pass to a foundation. Once the papers were signed, he checked himself into the Keith Richards Life Extension Center and had his doctors invite everyone up to see him.

Apparently doctors aren't bound by the same code of ethics that lawyers are. Or else they can be just as clever as we are in bending the truth. "We're doing all we can for him, but I don't think it will change his condition. All you can do now is hope."

Meanwhile he laid there silently, impervious to his family's questions and complaints, their prodding and probing, and their whining and cajoling. He told me later that it took a whole bottle of volazepam to get through the ordeal. When they left, they were sure he'd suffered irreversible brain damage from a stroke. And I was formally in charge of the Longstreet Trust.

It was nice up there at Keith Richards. He had his own private residence on the grounds, away from the rest of the facility. It was sometimes mistaken for the

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main building because it was so big. Anything to keep up the pretense.

"So what do you think?" he asked, when I saw him after returning from Boston. "Is that dike a waste of money?"

"I wouldn't buy it," I said. "It's a cash-eating monster. The cost doubles every two years, over and over. Try folding a piece of paper in half. You won't get much past the sixth or seventh fold. That's what it'll be like."

"Too bad. The Mayor wants one. He's been hot for it ever since the water chased him out of Gracey Mansion. Just around Downtown. Maybe Midtown too, if it works. That's his way of dealing with the cost."

"I suppose it makes sense to concentrate on your most expensive real estate," I said. "But I don't think it's financially feasible. Your costs are going to increase exponentially while your tax base decreases the same way. The last couple of property owners in the city are going to have to come up with the trillion megabucks they need to keep the dike up."

"And you've got a better idea?"

"What if I do?" I asked.

"You'd better tell me what it is. We're running out of time. Things haven't really started to fall apart yet, but they will."

"Tell me about it," I said wearily. When I wasn't running around the countryside admiring feats of civil engineering, I was trying desperately to plug leaks in the financial dikes that kept Vermilion safe. The economy was under tremendous pressure—the worst since the Crash, when the on-line investment syndicates had proved the bulwark against a long-lasting depression. The loss of valuable real estate undermined the whole structure of world finance. Behind most credit—really big credit, the kind that kept the world running—when you dug deep enough, you'd find real estate. Japan had always been wrapped up that way. The U.S. practically invented credit and real estate was always central to it. And the reason was that it remained constant and unalienable. You couldn't steal it. It never went away. Until now.

So the credit markets were in a blind stinking panic. Fifty years ago, the Feds would have stepped in, yanked up interest rates, thrown the economy into reverse, and used a recession to shake out the nervous and the unprepared. But the Crash had changed all that. Vermilion and its cohorts owned the banks—and the insurance companies that used to own the banks—and the real estate that built the insurance companies. We were trying our hardest to keep credit available, because it was the only way anyone could afford to take the drastic steps that would be necessary to escape the rising sea.

Thus far, we weren't managing well.

"Everyone thinks it's going to stop," I said in frustration. "They think it's just a warm summer at the South Pole and now that winter's back, the ice will stop and it'll all be over."

"How much time do we have before it starts to unravel?" Charlie asked, sinking back into his chair and looking suddenly frail.

"A few months. Maybe until the end of the year."

"And what's your great idea?"

I told him. He didn't like it at first, but I could see it grow on him as he thought about it. By the time I left, he was starting to get excited about it. I envied him.

On July 1st, the City Council approved the mayor's proposal to build dikes around downtown and midtown. To pay for it, they slapped a special levy on real estate. If we hadn't been ready for it, we might have been shocked, but in the end if fit right into our plans.

In August, Amundsen Projects launched a bold and risky mid-winter expedition to Antarctica. They sent three icebreakers down through the berg-filled waters of the South Atlantic, explored the surging ice, placed sensors and took core samples, made measure-

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ments and kept records. When I wanted to, I saw everything that came in before it was made public. I was notified when they made the report that gave everyone a few weeks of false hope at the end of the summer. The ice had slowed down. The glaciers were no longer racing along at ten feet per hour. They had dropped to only seven or eight.

Far too many otherwise sensible adults took that as a sign that the crisis had ended. The dikes still went up, block by block, shutting off the ends of one street after another. And the water continued to rise.

By the end of the summer, it had crept up to the plaza around the World Trade Center. It was seeping along Wall Street towards the Exchange, curling around the base of the Brooklyn Bridge, leaving brown high-water marks on Water Street, closing the South Street Seaport and the piers with all their old ships.

The dikes kept pace. They blotted out the view of the ocean all along the battery. They worked their way up the east side and the west. Another node sprouted up near the Holland Tunnel to shield the low ground between Soho and TriBeCa. The maps I saw showed that this was the most vulnerable part of lower Manhattan, twenty or thirty blocks that would go under by the end of the year if we did nothing to protect it.

Some people wanted to keep the dike going on up past Greenwich Village, others argued for drawing a line across the island at Houston or Canal. The engineers made arrangements so both plans could be pursued if necessary—though delay meant the loss of valuable real estate that could never be recovered.

Meanwhile, underground, they were sealing up subway tunnels, the PATH tunnels, the Holland, and all the storm drains and sewers with Cambridge Coral. It wasn't quite what the boys at M.I.T. had planned, but it was doing a good job. It seated into the surrounding structure strongly and grew quickly. I went down into the Chambers Street station and got a good look at it during an inspection tour one day in October.

By fall it was getting to be a pain to drive around. Broadway was always jammed with buses and taxis, and the overflow onto the other uptown avenues was getting just as bad. And with the water coming closer and closer, I decided it was time to move to higher ground. I grabbed a large suite of rooms at the Longstreet Tower up on Fifth Avenue near the Park—the old Trump Tower. It was a smaller place than I'd had in the Exchange, but I didn't entertain in town as much any more.

I was too busy. Both Charlie Longstreet and Vermilion owned a lot of real estate in Manhattan. Together they formed the largest single property holder in the city and even though their holdings were just a tiny fraction of the property on the island, they still owned some of the biggest and best spots. But not all of them, by any means.

Of course, it was all losing value as quickly as sea level was rising. We tried to unload as much of it as possible. In the short run, there was still money to be made on some of it, and we offered prices that couldn't be beat. In the long run, you could do a lot more with the money than you could with the property.

And what I was doing with it ran counter to everything the market was doing. That was what made it so much fun—and so easy.

First, I bought the Woolworth Building, a marvelous antique built by the man who invented interactive purchasing—minus the electronics. From 1913 to 1930 it was the world's tallest building, with an intricate, self-washing terra cotta facade, sitting on Broadway across the park from City Hall.

Then I picked up the Metropolitan Life Tower, the one with the big clock in it up at Union Square. A week later, I signed the papers on the Flatiron

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Building across the street. This was a real prize—the first skyscraper in New York City, the triangular building that looks like the bow of a ship steaming up Broadway for midtown.

If anyone had known I was collecting buildings, the prices would have gone up rapidly. But I kept it a secret, using some of Charlie's private reserves, some of Vermilion's cash flow, and a lot of hard bargaining.

The only alternative was investing in real estate outside the city. The Catskills and the Poconos were the hot spots that first year. The market was quick to shift from the sinking real estate of the old cities and the newer suburbs out to the untouched highlands on the fringe of development. Of course, it was all a speculative market, with the attendant risk. No one knew for sure where the new centers of commerce and transportation were going to be. It was much too soon for that. And that meant a volatile financial climate. In between picking up architectural relics, I kept hopping, putting out one fire after another.

By the end of the year, the first course of the dike around downtown was up. But things were starting to get scary. Large parts of south Jersey were going under for the last time. Florida was in trouble. Overseas, the picture was even worse. Half of Bangladesh was wiped out in one bad storm, and the other half was starving to death as the survivors descended on them. Those kinds of things couldn't help but shock the system and make it harder and harder to keep order.

And the mood in Manhattan changed in January. The ice started to speed back up.

After the first anniversary of the original announcement, the truth began to sink in. The sea wasn't going to stop rising.

The things people had been holding in for twelve months were starting to get out. Murders increased. Violence broke out almost at random—nothing like the 20th with its riots and gangs, but in a much more insidious, personal form—people hauling off and shooting strangers on the bus, old men throwing firebombs onto passing cars, mothers drowning their babies in the river. Business took on a more frantic edge as people found time starting to run out. And the demand for moving vans and rental trucks far, far outstripped the supply, with fifteen people already shot and three dead from arguments over them.

And then the kids started showing up.

They'd appear without warning, fill up a sidewalk in front of building, or take over a park, or fill up a bus on Broadway, or some other silly thing. They were always peaceful and polite. But they'd all show up at once, gathering from all over, then dispersing after a few minutes—never more than an hour—and returning to wherever they came from.

The reports were that it was part of some kind of cablenet game. But it didn't make sense to me. Of course, neither did shaving your head to pretend you were going bald.

Those of us who were in downtown Manhattan on May 13, 2047, know just what we were doing at 11:45 A.M. I was walking through Foley Square.

I'd just left the Woolworth Building. We were making improvements on the basic design—putting power units in the upper floors, sealing up subsurface access, trying as much as possible to make it independent of outside services. I took just a short walk up Broadway to City Hall, and then across the block to the Municipal Building—another of downtown's behemoth's rising up thirty stories from the grand arch at its center.

I was on my way to Chinatown to grab some lunch. It's just a short walk uptown—something you don't notice if you ride around in subways or taxis all the time. The shortcut is past the courthouses in Foley Square.

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I was in front of the Federal Court House when I felt the rumbling beneath my feet. It was like a subway, only they weren't running in this part of the city anymore. And it didn't rise and fall as it passed—*it just kept getting stronger.*

I remember that it was a bright, sunny day, with a cool wind off the Hudson. Pigeons filled the sidewalk, then rose up throughout the square everywhere all at once. Traffic was light, a pack of cabs jostling together at the corner of Center Street trying to get a recharge, a few police cruisers double-parked across the street, a lot of big lawyer-mobiles rolling by on their way to a garage. A woman in red came down the steps from the federal court, met a man in black who escorted her to the street on one arm. A trio of old men with white hair emerged from the New York Courthouse—probably judges. A cop standing next to one of the cruisers pulled his head out of the window and started talking into his wrist, looking towards the west.

A great sigh of air issued from the sewers and storm drains all around us. The air carried the wet, corrupt smell of decaying leaves, sewage, and earth—that slimy smell that coats the back of your throat and lingers with you.

Then I heard it.

It started as a loud hiss, like a steam line had busted under the street. But the hiss kept getting louder, until it turned deeper and more powerful. I didn't like the sound and hurried my pace.

I was almost across the square when I saw the brown-and-green shape loom in the distance. It filled an intersection, blotted out a storefront, swept aside a phone booth, overturned a cab, pushed down a row of newsstands, and grew taller and taller and wider and wider.

Then another appeared a block farther south. It climbed and grew as it pressed in on the square.

The echoes of a third tumbled down from the Municipal Building.

A frothy head of spray, foam, trash, and debris topped the rushing floods. The water spilled in from every direction now. And I just stood there for a long heartbeat, watching it come.

The dike. The wonderful Princeton Shield. It must have come down, I thought. "Great piece of analysis, counselor," I said aloud. The water was still halfway across the square when my nerves kicked in, sending me into a breathless rush past the courthouse, then right and up the hill.

I tried to remember what I could of the topography of the city in this neighborhood. Foley Square was down in a hole. Everyone knew that. It was the point of a lot of black humor that had been circulating for more than a year now. And Chinatown was uphill—but a few more blocks away. Was there anyplace in between that might be safe? Was there anyplace around that was lower and a potential trap for the unlucky? Did I have enough time that it made a difference?

I looked back, afraid that it was a mistake, but unable to turn away from the disaster. The streams of water had merged, forming one great curling wave, which rose higher as it climbed towards the courthouses. The surf climbed the street, tipping the police cars like toys, rolling them along.

The waves reached their peak as they crossed the curb. Then they fell onto the stone steps, first on the federal side, then on the state, shattering themselves *into sparkling lather.* The woman in red and her escort were gone. The cops were all gone. The cabbies were still there, forming a bulkhead against the waves as the flood came swirling around the corner and headed towards me.

I broke into a dead run, swallowing great pieces of sidewalk with every stride. I was behind the courthouse, moving along the narrow end of Columbus Park. The street ran uphill, and I was ready to follow it.

But then I saw a young woman, Chinese with shining black hair under a blue kerchief, and a little boy, with

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matching hair and blue pants. His little legs were pumping furiously, but he wasn't getting anywhere. And they were down the street to the left, at a low point on the block.

I tried to ignore that fact and was beside them in an instant. I grabbed the boy with one arm and picked him up into the air. I hooked the other arm around the woman's elbow and almost lifted her from the sidewalk as well.

We moved with impossible slowness as the water crashed across the basketball court and through the chain link fence. Some part of my analytical mind continued to work and offered the observation that the wide city blocks of Manhattan made a colossal sieve for the waters of the Hudson that were now rushing across the island. And that meant that it would be hard to predict how fast each street would fill or from what direction.

The street pitched upwards, giving me hope, but slowing us even more. I wanted to moan, but held back to avoid frightening the child, who remained silently astonished by the experience.

The roar of the flood filled the street now. I wasn't sure if the water was all around us or just the noise. The smell of riverbottom and gasoline was thick in the air, fish and petrochemicals.

Up the street at the far end of the park I could see the big pavilion. Every other time I'd walked up here, there were a dozen or so Chinese women sitting around the picnic tables in front of it, playing some card game—bridge, poker, something I never identified—something that had probably been going on there for a hundred years or more. The women were all gone now, but playing cards blew across the yard, flickering white and blue, white and red, as they tumbled over and over.

Then the water was all around us, cold and invading in my shoes and pockets, alive and devouring around my legs. It lifted us up. The woman screamed. The boy wailed. I moaned. It was brown and oily and thick with paper and cardboard and wrappers and cigarette butts and dead rats and squirrels and all the garbage of the street.

We pushed on, the water waist-high, then chest-high.

Then it broke over and around us, pulling me under, tugging at the boy and the woman, turning us all upside down. I held my breath and shut my eyes as I went under. Maybe I was afraid to see myself drown, or maybe I was afraid of what I might get in them if I left them open. I refused to let go of my two temporary charges—and they now clung to me for fear of death.

We turned and turned until I no longer knew which way was up. The world was all yellow light and the clatter of immediate yet distant noise that transformed submarine sound into something else. The temptation to open my mouth and inhale a great gush of filthy water was overwhelming. My chest ached, my ears buzzed, my vision darkened, then filled with bright white light, and the sounds all went away. I knew I was drowning, but no life passed before my eyes.

For a moment, though, I felt a serenity that I had never known before, pouring over everything like oil, like the flood itself, erasing the foundation of suffering and washing everything clean. As a Catholic, I knew what this meant—the pure grace of God. But as a lawyer and a creature of the 21st century, I never really believed that for a minute. It was certainly something else, because I knew it couldn't be that.

Then my head broke through the surface of the water into the air. I gasped and choked and coughed and drew in another breath—as did the Chinese boy on my left and the woman on the right.

I felt the ground beneath my feet. I planted my legs hard against the pavement and offered stumbling resistance to the wave. Finally the water let us down. We pulled free, stepping high, splashing hard. Then we were away from it.

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My pants were heavy and stuck to the skin, my shoes squished like old sponges, and the breath that came in and out of me sounded like a broken accordion. We pulled ourselves up the street, away from the still surging waters as they rushed on towards another block, another park.

I could still smell fish. Then I realized we had reached the edge of Chinatown, with a whole block of open air seafood markets lining the way to Canal Street. And we were alive.

The city lost 1,510 citizens that morning, but that wasn't all.

It also lost hope.

The mood was different after the dike broke. No one talked about fixing it. No one talked about extending it uptown. No one talked about much of anything to do with the flood or the rising tide or anything but work, home, life, and the cablenet.

I felt like something had broken inside me. That moment when I came close to drowning had left me transformed. Nothing that was important before seemed to matter any more. For a lapsed Catholic, I was feeling an awful like a true born-again Baptist. Now I understood why they put their people under water like that. It was like nothing I'd ever experienced before. Things that I'd once considered vitally important were now inconsequential.

I even lost interest in collecting buildings.

I'd already picked up all the ones I really wanted—the Equitable was the last of my prizes. I had acquired almost every piece of prime property below Canal Street with the exception of the World Trade Center—and that was too big a power in itself for me to grab it without making a big public scene and revealing what I was up to. I mean, they even had their own dikes.

But the thrill of collecting them was long gone. For months I had been pursuing them, working deals left and right, all under cover and through third- and fourth-party go-betweens. Then suddenly I was fed up with it. I knew I was using the activity to hide from something.

And every once in a while, I caught a glimpse of what that was.

Guilt.

It would hit me without warning, bubbling up like some bad marinara sauce or the first hints of angina. Then the hot flashes would start. And I'd start to wonder what I'd done that was so wrong that I felt like this.

It wasn't a lot of fun. And the worst of it was that it didn't come with a label to help me figure out where it came from. I figured it had something to do with the flood, but that was just a thought. It did nothing to quench the emptiness that opened inside me every time it hit.

Sometimes it was so bad that I thought about going to a priest for confession. But the very absurdity of such a thought was usually enough to break the spell.

Without the Princeton Shield, the water had settled along its natural shoreline. City Hall commanded a small island that started down at the Exchange and ended up in Tribeca, where waves lapped against cast iron buildings a century and a half old. The Trade Center's dike kept it dry for the moment, but Foley Square was a channel separating the south island from the rest of Manhattan. Chinatown was still high and dry, and you could still get onto the Brooklyn Bridge at low tide. The Lower East Side was a shallow sound under the Williamsburg Bridge. And farther uptown, the waves lapped at the Washington Square Arch on the west side and Gramercy Park on the east. Half of SoHo was gone. And the waters were at the door of Little Italy.

When I was a kid, growing up around the corner from Mulberry Street and the big welcome sign, I thought Little Italy was a part of Big Italy, separate and independent of New York City and the rest of America. I remember telling that

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to a cop when he caught me stealing tomatoes off a box at the market.

"You can't arrest me, you're from New York and this is Little Italy." Once he stopped laughing, he brought me home, where I got a lecture on law and political geography from my father.

Watching him move out of the apartment where he'd lived his entire adult life broke my heart. He and Mama were heading upstate. Her family had found a place in one of the new neighborhoods upstate in Binghamton (above the maximum high water mark calculated by Amundsen Projects) and some nice real estate agent (acting on the orders of some big shot in New York City) made them an offer they couldn't turn down. Everyone was going up together. Somehow they'd found moving vans and movers despite the demand (another favor from the big shot) and had packed their stuff away for the long ride up the Thruway.

I hugged them both, waited on the sidewalk as they climbed into the truck and drove off, then strolled on down a couple of blocks to the water's edge. This street used to be my playground. Now a line of blue-and-white police sawhorses blocked the road, with flashing amber emergency lights chained to the lampposts. Little waves, pushed by a gentle breeze, rolled in and lapped at the curb. Sea gulls waddled along the pavement, making rude noises at the pigeons.

Part of my life had ended. Everything up until now was over. Soon the waters would swallow up my past. Then my present. And eventually my future. At first, I wondered if I'd gone under the floodwaters in Foley Square as a Catholic and come out as a Baptist, the way I felt reborn afterwards. But it didn't take long to realize that nothing was going to appear to take the place of my old life. Watching my parents move out was the last piece to that picture.

I turned away from the little asphalt beach and went back uptown.

* * *

The next year, the third year of the flood, really did us in.

Over the course of the winter, the water closed in on lower Manhattan from every direction. I discovered that Broadway ran along the spiny backbone of the island, the high ground from Times Square south. By Halloween it was the last thing standing below 35th Street—along with the Flatiron Building, Union Square, and Cooper Union. The World Trade Center and Bellevue continued to hold out behind their dikes—all that was left of the Princeton Shield—but they were both half a mile from the nearest dry land.

The U.N. building got its feet wet every time the tide came in. Waves broke against the walls of Madison Square Garden, and the Port Authority Bus Terminal had to close its lobby at last. And shallow tendrils of tidewater were reaching towards Times Square and Central Park, enveloping Midtown in their clammy embrace.

I was pretty much out of the real estate business. Since I'd figured out the tricky parts long ago, I hired some people and showed them how to do it. And in any case, the buildings were all being set up as independent, self-managing units, with ownership hidden deep, deep behind layers and layers of legal papers. There was no special expertise to planting Cambridge Coral in a basement and letting it grow, so I wasn't needed for that.

Instead, I wandered around the city, walking the streets at all hours of the day and night, in the steamy August night, in the sharp sunlight of September, in the aromatic afternoons of October. There was no pattern to my wandering. I just wanted to see the hidden corners of the place once more, listen to the pattern of echoes and street sounds, smell the secret scents, and surround myself with the concrete and stone and steel and the boundless diversity of humanity that made New York city real before it was all gone.

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I watched the last families clear out of Chinatown as the brown water surged with the tide. I saw the Indonesians packing it in over in the Tribeca. When they evacuated Greenwich Village, I spent a week in Washington Square Park watching aging Bohemians filling trucks with a hundred years worth of paintings, sculptures, mobiles, and etchings. I joined in the last round at many an Irish bar on Third Avenue as the yellow police line moved uptown. And I spent Halloween in Central Park, waiting for the witching hour.

Kids were everywhere. They were all playing that cablenet game, Walkabout. They called it that after the police threatened to arrest them for loitering. "We're just walking about," they'd say as they all took off when the time was up. Every few minutes, another crowd would appear in another part of the park. It would swell, spill over sidewalks and curbs, abruptly turn loud and excited and bursting with energy, and then evaporate in just a few minutes.

I managed to avoid them. The trick was learning to see them coming. It always started with three or four people standing in one spot grinning at one another, but not saying a word.

But some things are impossible to avoid.

"Hey partner, warm night, even for October, isn't it?"

I bristled even before I turned to see who spoke to me. Vermilion called its subscribers "partners." It was meant to be an attractive image to sell shares, but inside the company, it took on a more derisive meaning, something akin to "pigeons" or "marks." No one who worked for Vermilion used the term unless they meant it that way. When I saw who it was, though, I relaxed. Peter Kelly, Charlie's wayward great-grandson, smiled and tipped his hat.

"Yes it is," I said, looking him over as we walked past the big bronze statue of Alice in Wonderland. He still shaved his head to make an early widow's peak, but he was noticeably older than when I'd seen him last, old enough not to worry about curfew violations anymore.

"How goes the chase?" he asked.

"The chase?"

"The hunt for profits, the great race to win the prize, the chase," he said.

"I'm sitting it out right at the moment," I said. "It's lost some of its appeal."

"Getting harder to squeeze a megabuck out of the market, is it?"

"It's getting harder to find a market that isn't about to collapse."

"So I've heard," he said. "So I've heard. Say, tell me—did Amundsen Projects ever find out what caused it? The Big Melt, I mean."

"What caused it? Global warming, of course. They're still arguing over how so much heat got so far south so fast, but that's all there was to it. Once it got warm enough, things started to slide."

"And global warming, how come no one ever stopped it?"

I stopped in my tracks. "Come on, what kind of question is that?"

"A legitimate one. You're a smart guy. Your education is top-line. So tell me why you think no one ever did anything to stop global warming."

"Who was supposed to?" I asked. "The government tried, back in the 20th, but that was before we cut it down to size. Big corporations might have, if they hadn't been knocked to pieces during the Crash. Vermilion and its sisters were the only ones around big enough to do it afterwards, but that's not our business."

"'Not our business.' That's an interesting way of putting it."

"Well it's not. Our business is to provide a service to our members. Not to dictate social policy."

"Even if it means letting the ice caps melt?"

I sighed. "There are a great many services that are within the power of Vermilion to deliver. Saving the world from itself is not one of them."

"Of course not," Peter said. "It's just

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an interesting moral dilemma. Though I don't suppose everyone would see it that way. How about you? Do you think morality has any place in business?"

"That's a leading question and if I were in court I'd object."

"Then let me rephrase it. What is the relationship between morality and business and what do you think it should be?"

"In business, you don't talk about morality, you talk about the law. What counts is whether you obey it or not. Whether it's moral or not is a question for courts and politicians. Vermilion offers a service. Other businesses manufacture products. Once we make sure everything's legal, we're pretty much finished with any questions of morality."

"You are, aren't you? And there's no question about higher moral duty, is there?"

"A higher moral duty? The catch there is easy to spot. Whose morality do we use? Yours or mine? What if yours is just a clever argument in favor of your own interests? Or mine? No, once you bring morality into it, you just open a box full of mischief."

"I suppose so," Peter said. "It's funny. That's what Grampa Charlie told me you'd say. He said my grandfather would claim there is no morality. And my father would say morality is about not letting your friends and family down. He said you'd claim it's whatever the law allows."

"You talked to your Grampa Charlie recently?" I asked, suddenly abuzz with surprise. For a brief moment, I saw years of careful work keeping Charlie's secret all washed away.

"Last week. He sends his regards. And he said to tell you that I'm very good at keeping secrets, so you shouldn't worry about me."

I tried to relax my pounding heart. The best thing to do, I decided, was take the initiative. "And what about you?" I asked. "What do you think about morality and business?"

Peter smiled, then tipped his head back and forth as he seemed to weigh his answer. "I don't know if I could tell you that without offending you," he said. "Grampa Charlie said I should tell you to ask him sometime. We see it from pretty much the same angle."

"I'm not sure I like that," I said.

"I'm sorry," he replied. "But I'm afraid you wouldn't like the alternatives any better. Not tonight. Maybe later. In the meantime, I have someplace I have to be in a couple of minutes. It's not far, if you'd care to join me."

"What is it?"

"Just a Walkabout. It's scheduled for midnight at the park entrance. We're almost there now—and it's on the way home for you anyway, isn't it?"

I admitted as much, but not gladly. The last thing I wanted to do was take part in a Walkabout.

But a few minutes later, we were there, along with a row of horse-drawn carriages that ran down Central Park South, across the street from the big hotels—we owned three or four of them. A couple of young men with artificial bald spots came out of the park and joined us without saying a thing. Then a girl in a blue dress and her companion, a man my age in a grey suit, crossed the street from the Majestic House and took their places beside us.

I refused to grin, but I kept silent, not knowing the etiquette. More and more people arrived. Within ten minutes, we were surrounded by dozens of strangers, then maybe a hundred or more. When the crowd had spilled into the street, and cabbies had slowed to a halt to avoid hitting us, and the horses had grown nervous at the sheer size of the group, a chorus of voices called out: "Time!"

It was as if the lights had come on at a surprise party. Suddenly everyone began to laugh and talk and shout and swap stories and introductions. The noise was astonishing in its intensity, as if keeping it bottled up gave it an extra push.

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I smiled at the genuine openness of the participants and their readiness to share intimacies with people they didn't know. But I kept apart from them, not quite there voluntarily. Peter seemed to appreciate that.

"Don't let them make you uncomfortable. They're just ordinary folks," he said. "But it is a tremendous demonstration of power, don't you think?"

"Power?" A light went on my head somewhere, though I wasn't sure at the moment what it was illuminating. Certainly a much wiser and more complex Peter Kelly than I had suspected until that moment. But I was sure there was more than just that.

"You'll see a much better demonstration a week from Tuesday," he said.

"A week from Tuesday?"

"Election Day," he said with a smile. "Or did you forget?"

Ordinarily, I would probably have forgotten to vote. It was just a municipal election. I didn't like the mayor personally, but I had no particular interest in keeping him in or booting him out. These were no longer ordinary times, however, so I went down to the polling station on the corner.

They used to talk about computerizing elections, but the talk never got anywhere. At first, no one wanted to encourage people to vote that much—it made elections harder to control. After the Crash, governments couldn't afford the cost of the equipment. So we still had to walk on down to the local polling station and stand in line to cast our ballots. Personally, I thought it was worth the trouble to reinforce a sense of the public nature of voting, but I was in a minority.

I went down in the late afternoon and didn't have to wait long to take care of business. The ballot offered a momentary amusement. In addition to his honor the incumbent, there were half a dozen candidates from parties I'd never heard of—including a Joe Sturdley from the Silly Party and a Bill X. Carlson from the Anarchy Party.

I decided to stick around after I was finished, though, and stopped for a hot dog and a soda from a street cart. I didn't have to wait much before a small knot of people formed. I recognized their silly grins. Before long, there were twenty or thirty of them, not a large group by Walkabout standards. Then someone called time.

But instead of breaking their self-imposed silence in a round of socializing, the group turned around and went inside. I tried to avoid choking on the last bit of my lunch and rushed after them. I wanted to see what they were doing. When I saw, I was surprised—and a little frightened.

They were voting.

That must have been why the group was so small—registered voters only.

That night, when the polls closed, the mayor was history. Someone named Randolph Sweet had won the election. According to the biolink, he was a social worker with a degree from Yale, he was married but childless, he lived on the upper East Side—and he was twenty-two. That nearly floored me. The city of New York had elected a kid as its new mayor.

The City Council was the same story. Everyone who had been there in the morning was swept out of office by the end of the night. And every one of the newcomers was under twenty-five.

Nationally it was the same story. Local and municipal elections all over the country showed the same results. Fresh young kids with no experience, no record, no previous public profile, and no evident campaign organization had won every single election in every town, city, and state in the country.

My back buzzed with nervous energy as the magnitude of the event sunk in. What in the world was Peter Kelly involved in? And what were they up to?

* * *

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Before anyone could find out, we got hit by the Little Crash.

It was late November, a week before Thanksgiving. On Monday the banks started going under. They were all on shaky ground and had been for months. They depended on revenue from loans paid back, and with the water rising and more real estate going under every day, the loan payments had started to dry up—especially now that we'd reached the forty-foot level. But no one expected them to collapse all on the same day.

In retrospect, they should have. They were all linked together in one majestic network, and as soon as one went down, the others started to wobble out of control, spiraling in on themselves in a sudden outflow of capital.

On Tuesday, the insurance companies went under. They owned the banks, for one thing. And their claims had risen along with the seas. No one was buying new insurance, no could afford the premiums they were charging, and their investments no longer offset their losses. And like the banks, they were chained together in huge networks.

On Wednesday, the stock markets closed. The run from losses in banking and insurance was certain to bring the entire world financial system crashing down as investors tried to sell before their investments lost their value. The few big corporations left standing by the Crash went under before they could shut down the outlinks.

And on Thursday, the on-line syndicates faced their moment of doom. They couldn't close their doors—they had none. They couldn't stop people from bailing out—they were creatures of the old Internet, wild, anarchic conglomerations of anonymous computer and credit accounts. Like the Internet, they were designed to be without barriers, free to flex and fly on the winds of the moment. At this moment, the winds were blowing everything out the door.

We were braced for it. We lost a lot of virtual money, but we kept all our tangible assets—the property in the Poconos and the Catskills, the still-secure Midwestern holdings (including a good chunk of Chicago real estate), the service sector. But without banks, insurance, and stock markets, we couldn't do a heck of a lot.

So on Friday, everything just stopped. Buses quit running as the city found its accounts empty and no way to buy diesel fuel. The few subways that were still in operation stopped as the power went off in huge parts of the city. Employers declared a holiday, leaving people free to worry about what would happen next. Traffic ground to a halt without signal lights. People pulled over and left their cars on the curbside, which only contributed to the gridlock.

The only thing still working was the cablenet—though without power most wallscreens were off-line.

By suppertime, it was crackling with all kinds of rumors, paranoid theories, political screeds, and wild ravings. I chained my way across a lot of scary sites (the Longstreet Tower had its own fuel cells to provide power) and was growing more and more concerned when I got an e-mail message from Peter Kelly.

"Walkabout in Central Park at six o'clock sharp. Everyone in New York is invited."

I got there late. The evening was warm for early November—almost shirtsleeve weather—with a low deck of clouds picking up the lights from the city. I could hear the noise as I stepped out of the Longstreet Tower's high glass-walled lobby and onto Fifth Avenue.

It sounded like everyone who was invited showed up. The sidewalks were full of stragglers, working their way uptown towards the park. They spilled out onto the road, ignoring the traffic and confusing the small brains of the cabbies.

When I got to the Grand Army Plaza at the southeast corner of the park, I

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found out why the noise was so loud. They'd seeded the park with soundies. They were everywhere, little orange balloons drifting on the breeze. The flat ones that had landed and deposited their speakers looked like dead butterflies. Someone was giving a speech—her voice was everywhere—but the sound of the crowd was being carried on more than just the wind.

I couldn't understand exactly what the woman was saying. I didn't stay put long enough. Besides being illegal, the problem with soundies is that they aren't that good. I suppose I could have grabbed one and stuck it on my shoulder, but I wasn't really interested in what she had to say.

I kept on moving, working my way around the edges of the throngs of people who filled the streets and walkways of the park. I knew some of the shortcuts and managed to get past the chokepoints where the mass of people had brought all movement to a halt.

Eventually I got up to the Great Lawn, where the speakers were invisible, surrounded by a colossal crowd. But down in here, the soundies were dense enough that you couldn't help but hear every word.

Mayor-elect Randolph Sweet was already talking when I arrived. It was the first time I'd ever heard him talk. He wasn't a powerful speaker, but this crowd, young and excited, seemed to love him.

"I'm still astonished that you put me where I am today," he said sheepishly. "I just hope I don't let you down." He went on like that for a long time, trying hard to make sure that everyone knew how humble he was and how much he wanted them to like him.

Then he started getting tough.

"We didn't create the mess we're in today, but we're going to have to clean it up," he said. "And I don't think we can wait until January to get started. Do you?"

The thunderous response was thrilling to hear and feel, even if I wasn't joining in.

"Well I don't want to. Do you?"

Another wave of thunder rolled over the lawn.

"I don't think we should have to. So tonight I'm calling on the mayor and the council to step down, resign, stand aside and let the newly elected officials take their places. There's no time for delay and no time to waste. Let's act now, before the water's in the basement. Who's with me?"

The crowd had no well-crafted response to that question, but the roar of affirmation was just as loud. I decided I'd had enough. This was not reassuring to me at all. These kids weren't just playing politics, they were playing at revolution.

It took a long time to get home, bucking the people still flowing into the park and uptown. And when I got there, I found a message from Peter Kelly.

"Think of this as a courtesy call," he said when I called him back.

"Courtesy has nothing to do with what you and your friends are up to," I said. "I have to admit that what you've done so far is impressive. But there's more to running things than getting a bunch of strangers to meet on a street corner and act silly."

"We do have a plan," he said.

"A plan? That's good to know."

"And you're involved. That's the courtesy. I just wanted to warn you."

"That was considerate of you. Warn me of what, exactly?"

"We have the cities. That's a given. Come Monday morning, the mayor and the council are going to get out of City Hall so fast it'll make your head spin. They don't want to take the blame for what's happened. But the cities aren't enough. So on Tuesday morning they're going to come knocking on your door. They need Vermilion and the other on-lines in order to get things done. You're all they have left. That and a lot of strangers who meet on street corners and act silly."

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"You know it won't stop at that, don't you?"

"At what?"

"At asking for help. They're going to want control. Control over Vermilion and all the rest. And that means an end to our freedom. These things don't stop once you get them started."

"You're probably right about that," he said. "But it's too late now. The water's in the basement."

"The mayor was only the first to go. Sooner or later, they'll be coming after me."

"I'm afraid you're right. I guess that's why I called. To let you know. To be sure you knew."

"In that case, thank you for the courtesy. And good night."

It took them a long time, but eventually they came for me.

Not until after they'd run me ragged trying to help them dig themselves out of the Little Crash.

It wasn't like the Big One. That had been a lot more fun, from what I understand. The system to protect the banks had worked so well that everything ground to a halt. Instead of writing off bad debt—one of the positive functions of a depression—the Feds struggled to rescue it. Within a year, the federal government had been reduced to bankrupt irrelevancy, and Wall Street and the bankers were looking for help from anyone else in a place to give it. We were more than happy to give it to them.

This time around, the other side—the kids—didn't want to need us, and we didn't want to help them. But neither of us had a choice.

So once again we pumped life back into the banks, this time bypassing the insurance companies. We had to find slack somewhere. And they were the dead weight on the system. All those losses couldn't be made good. Trying to would only bring everyone else down. So we let them fold, each and every one.

Then the utilities came back on line. Followed by the markets, though not without a few quick shutdowns as things overheated.

Vermilion managed to survive the experience for the first few months, celebrating the new year and the spring, lamenting the springtide as it wiped out more and more of the city.

I moved out of the Longstreet Tower in January. There wasn't any water in the basement, but they had started slapping Cambridge Coral all over the ground floor, making it too difficult to get in and out of the place. My new apartment was in the Dakota, overlooking Central Park. It was just a few blocks down from the Museum of Natural History—or what had once been the Museum of Natural History. Now it was just a shell. Vermilion trucks had moved the entire collection to its new home in the Catskills.

I expected them to come for me sooner, but they were getting ready for the next election—the federal elections for Congress and the White House. It wasn't going to be as easy the second time around. For one thing, the Feds were fighting back already.

In April they tried to put a stop to the Walkabouts, but the local police wouldn't cooperate. They worked for the cities and the kids had the cities—three hundred of them, large and small, all across the country. So they sent out the FBI, trying to hunt down the organizers by tracking them through the cablenet. They claimed the Walkabouts violated the New Computer Indecency Act, but they never explained how. They arrested a few kids who fell into their traps, but there were too many people scheduling Walkabouts without any coordination from a central organization. In the end, they never even prosecuted the ones they'd nabbed.

In May, the sea found its way into Grand Central Station—her trains silent for more than a year already—and surrounded the Empire State Building.

By June it had swamped Times Square

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and was inching its way towards Rockefeller Center. The lobby of the Plaza Hotel on Central Park South was soaked with brine and worse at high tide on Independence Day. Farther uptown the high-water mark had reached Columbia University and the Cathedral of St. John the Divine. Everyone knew it was going to be a long, sweltering summer, made worse by the waters filling the streets of Midtown, growing steamy from the midday sun, and turning the remaining dry blocks of Manhattan into a miserable swamp.

In July, they arrested me.

The charge was profiteering.

They didn't call it that exactly. It was a city ordinance passed by the Kiddy Kouncil—as the over-thirties called them—that talked about continuing to receive income from a source deemed by the courts to constitute an unfair business practice and anything else that gave them an excuse to lock me up. The terms of the ordinance were broad enough that they could arrest anyone who'd ever had an account with Vermilion or Chartreuse or the whole crayola box of on-line syndicates. But they only used it against the top of the food chain, and that was me.

The case went before one of the new city courts they'd created over the summer to handle their new laws—like the one that banned internal combustion engines from the city limits. I sent my Brickyard Roadster into storage up in Connecticut when they did that.

The trial was mercifully brief. The judge was Rennie D'Amour, the young federal clerk from the original Amundsen Projects case. He was a few years older than the folks who'd seized political power in New York City, but young enough that he could pass himself off as one of them. An older, wiser, one of them, worthy of being a judge. He still looked overworked.

I was guilty, of course. They'd written the law to get around the ex post facto rule, but it was aimed at the on-lines and the guys who called the shots for them. Everything we'd done to prepare for the flood was considered profiteering—and it was.

We'd made a lot of money buying up the assets that would be needed to handle the impact of the rising sea. We thought we were doing the right thing, mobilizing resources for a crisis. But the kids didn't agree. Let he who is without sin cast the first stone . . .

"Mr. Russo, is there anything you can say in your favor to mitigate these charges?" D'Amour asked when they were nearly finished with me. "Any extraordinary accomplishment to further the public good without profit to yourself or your employer?"

I realized as I stood there that I was stuck in a moment of sudden truth. My neck was on the block and I had it in my power to save it. All I had to was betray a man who trusted me with everything he owned, with his deepest secrets—or some of them, anyway.

It seemed so easy in contemplation, but so impossible in execution. I could no more do that than I could betray my own father. I had spent many years cultivating the image of the cold, calculating attorney, the kind of man who wouldn't hesitate to sell out his friends, his family, and his soul for the right price. But I guess it was just an act. Because when it came down to it, I couldn't reveal what I had done—no matter how much suffering it would spare me.

So I remained silent. And Rennie D'Amour found me guilty and sentenced me to ten years behind bars.

The first months were the hardest. The jails had gone under long ago—the Tombs downtown, the Crypt on the low Harlem plain—so they stashed us in the only big, solid buildings they had.

I spent the time in the Metropolitan Museum of Art.

It was a strange kind of limbo. We slept on pallets on marble floors and

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awoke each morning to elaborate carved stonework high overhead and blank walls where pictures had once hung. They never turned on the heat, and the winter left the place miserably cold. We spent each day in tedious, unrelieved boredom. It was interrupted only by the arrival of a new lot of inmates—mostly lawyers, bankers, executives, city officials.

We had nothing else to do but talk, and we talked a lot. Mostly about what we'd done to get arrested. Everyone felt ill-used. No one felt remorse. But we sat around on hard wooden benches droning on and on about all we had been and all we had done. We were like ghosts in the afterlife, recounting our deeds on earth. The classical stone columns and marble muses and angels that decorated the chambers completed the scene.

I had a lot of nightmares—church dreams, with devils and pitchforks and angels and Bibles. I grew up believing in a physical Hell, where devils shoveled hot tar into your mouth for all eternity to punish you for your sins. I was ten or more before I realized it was all a big lie, but I don't know if I ever got over it emotionally. The nightmares were full of that stuff.

And the guilt attacks were worse than ever. Being locked up all the time didn't help. Now they went on and on, sometimes for hours. At least now I could put a name to my sins. But I wished I could return to the days when the guilt had no author instead of moments of deadly precise understanding of all I had done and left undone.

In the beginning, most of the inmates were like me, decision-makers in the big institutions. The kids were being systematic and comprehensive in eliminating the people who could stop them from gaining control of the on-lines. Gus Karmonos showed up a month after I got there. He was still with Chartreuse, or rather the shell of Chartreuse that we let loose on the streets, when they pinched him.

"I don't understand, Johnny," he said. "I didn't do anything wrong. I may have stretched the law here and there, but I never went over the line. I never had to. I always thought it would save me in the end. I played by the rules. This shouldn't have happened."

"I know, Gus. That's what makes us political prisoners. It's not what we did, it's who we are. And it's what the kids want—which is the power we used to have. You don't have to do anything wrong to get in trouble that way."

"I still don't get it, Johnny. We were just playing by the rules, doing what was expected of us. If you can lose everything because you did what was expected of you, then nothing makes sense anymore. Nothing."

"Yeah Gus, but those things all changed. They've all washed away now."

"Nothing makes sense," he said,

After Labor Day, another group started coming in. It consisted mostly of older men and women, many of them retired. They were the ones who'd had a chance to change things and didn't. They were the ones the kids blamed for melting the ice caps.

They were nervous and scared. From what we heard, their trials weren't like ours. They had an element of ritual humiliation and threats from the judge and the prosecutors of more serious punishment down the road, after the elections consolidated their power. They kept to themselves and never discussed their pasts with the rest of us. They'd learned not to in the years since the flood began.

Then one day an old man with snowy white hair and a face like a dried-up potato broke the silence. He was talking loudly in the corner where those people congregated. And when one of his companions tried to restrain him with a touch, he threw off the man's arm and stood up abruptly.

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"I won't be silent any longer," he said loudly. "You are all outrageous. Why won't you admit it? Why won't you accept the blame? We did it. We all did it. You thought that once the boomers were all safely put away in their retirement homes that you could just trash the planet. You told lies about how responsible you were being all the while you were plundering the rain forests and fouling the oceans and corrupting the skies. And you knew it was wrong. You knew and you never moved a hand to stop it. I'm sick of you all. Just sick."

His friends finally calmed him and withdrew to their corner.

"Crazy old man," said one fellow on our side of the room. I recognized him—a lobbyist who used to work for Vermilion. We'd fired him when we found out he was lying about his expense account and he went on to work for the tobacco industry. "They ought to lock him up."

Everyone laughed when he caught himself and realized what he'd said. Everyone but me.

"He's right, you know," I said. "We did it."

"Did what?"

"We screwed the planet. We melted the ice caps."

The lobbyist shook his head and made a disgusted face.

"And no one wants to admit it," I added, trying to force him to face the truth. I don't know why I did it. Maybe I was just tired of listening to everyone make excuses for themselves. Like the old man.

"We've been talking about this for months. Everyone agrees we were negligent. There are enough lawyers in here to recognize the elements of the crime, just ask them. We knew the potential consequences of our actions and we ignored them."

"We were just giving the people what they wanted," the lobbyist said. "Nothing more, nothing less. It's what the market wanted."

"But everyone in this room knows that's a lie," I said. "We all know exactly what we did and when we did it. When it came time to decide how things were done, we decided what was best for us. And then we went out and sold the idea to the public so they'd think it was a good idea. I know because I was better at it than anyone.

"And don't tell me we were just giving people what the market wanted. We were the market. Those kids know that, and that's why we're here. For all their faults, they're at least innocent on the big count, you know. Maybe that's why they're getting away with as much as they are."

"Aw come on, everyone knows it was too late to stop the warming back at the turn of the century," the lobbyist said. "If you want to blame someone, blame the boomers. If they hadn't stopped nuclear power back in the 20th, then we could have stopped global warming in its tracks. They're the reason we burned all the coal and gas and oil, not us."

I wanted to go on, but how could I argue with logic like that? And the idea of being locked up with a room full of men who were hostile towards me personally was not at all appealing. Things could indeed get worse than they already were.

So I shut up and let the argument die. No one cared what I believed. Or so I thought at the time.

That night they took away the old man who had spoken out. He never returned, and no one could tell us who he had been before he was arrested. No one could tell us what had happened to him.

A few days later, I was awakened in the middle of the night by someone shining a flashlight in my eyes. For the next few minutes, I thought my time had come as well.

It was one of the guards—a kid, the only kind they let near the political prisoners. He led me out of the hall where

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we were kept and down a flight of road stairs. We stopped on the landing and he reached into his pocket. I panicked, afraid that I was going to get it right there, but all he pulled out was a cell phone. He punched in a long number and handed it to me.

"Hello, Johnnie," said Charlie Longstreet. "How do you like being in jail?"

"It's not as bad as law school," I said.

"Sorry about this, John. I wish there was something I could do to help you."

"If there were, I'd have asked you to do it," I said. "I'm not that humble."

"I'll keep working on it," he said. "So-o, how do you like my kids?"

"Your kids? Have you got something to do with them?"

"Just a little," he said. "I'm just hedging my bets. They looked like they needed a little help."

"Charlie, exactly what kind of help have you been giving them?"

"A little money now and then, just to keep things going. And a little advice. Well, a lot of advice. I haven't had this much fun since I was a kid. Power to the people, smash the state."

"You were in the Navy back then, weren't you?"

"Yeah, and I missed out on a lot of the excitement. Now I'm trying to make up for it. Just wait until the election. We've been busy. The oldtimers like you and me don't have a chance. You should see the polling we've done."

"I thought polls were still illegal."

"So? Ours show that the kids are going to win everything. And do you know why? Because everyone thinks they're right. Even oldtimers like us think we should turn things over to them. They've given up on themselves. Doesn't help that they're all a bunch of damned sheep."

"And what's going to happen if the kids win?"

"They can't do a worse job than the people who are there now," he said.

"I'm not so sure about that," I countered. "I've talked to Peter Kelly. He's got a lot of you in him, but he's still a kid. They all are. Do you really think they're going to pull this off without crashing when the time comes to make the hard decisions?"

"They were smart enough to lock you up, weren't they? That one was their idea, not mine. They can be ruthless when they have to be—and the times call for that."

"But can they be wise when they have to be? It takes more than a silly haircut for that."

"That's why I'm staying involved, Johnie. I've got more than enough wisdom for all of them."

I just shook my head and said nothing.

In November, the kids won the election. Now they had the Congress and the White House, the legislatures and the governor's mansions. And now that they had the big power, they were making big changes. In February, they moved us.

We boarded buses one morning, headed crosstown through the park, worked our way to the west side, and pulled up at the water's edge. We filed off the buses and out a long boardwalk that stretched for two or three blocks. A ferryboat was waiting for us—one of those hydrogen-electric boats that the Indians built up in Connecticut to haul gamblers to their casinos.

I got a seat by the window. That was the last I saw of Manhattan for a long time, as the boat cruised out into a frighteningly broad Hudson River and headed north on the incoming flood tide. I saw row upon row of silent buildings rising out of the water behind us.

They took us to Albany, then put us on buses. We rode all night long and ended up in what used to be Fort Drumm, almost at the Canadian border. We spent a few weeks there while they sorted us out.

If the Met was some kind of limbo, then the next phase of our imprison-

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ment turned out to be purgatory. One by one, we went before a young man or woman to have our sins evaluated and our fates decided.

The old-timers were sent off to some remote part of the camp. We heard stories about it later. Nothing was done to them there, but nothing was done for them. They were housed and fed while they completed their terms, kept up in old army barracks, with no work, no books, no computer outlets, nothing. All they had to pass the time was themselves and one another—and the knowledge that their grandchildren had condemned them for their sins.

The rest of us were divided into two groups.

Those who were unrepentant, who still bellowed about the injustice of their situation, who denied any responsiblity for the world's precarious position and any role in putting it there, were sent to the farm. The farm was not the preferred assignment. The work was dreary and dull and didn't require much thought. Its only reward was that you got tired enough during the day to fall asleep quickly at night.

The others were shipped out, dispersed across the state, and sent to do other jobs. Interesting jobs that involved useful work. The kids weren't mean and they weren't dumb. They knew that they had a lot of talented people locked up. And they didn't want to let all of it go to waste.

The talk was that they knew just who they had and what we'd been saying since we were locked up. That was how some of us got the good billets and others ended up on the farm, people said.

I drew a building contractor's assignment in Tupper Lake, a little town in the middle of the Adirondacks.

In the next year I learned more about lumber, power tools, and construction methods than I ever imagined I could. I discovered that green was a more intense color than I'd ever imagined and that it came in more shades than I could ever count. I was astounded by the real ization that water rises from the earth and spills down in brooks and streams and rivers into the sea in a torrent tha never stops, day or night.

In the year after that, I got to be very good at the job. There was something about working with your hands and sol id, substantial materials that I'd neve guessed I could enjoy when I lived down on Wall Street.

I barely noticed the third year passing My life had become simple, ordered and routine. At night we were locked up inside a housing compound in som small town in the Adirondacks with on traffic light and one phone booth.

It seemed pointless to me, since ther was nothing to run away to in a plac that remote. One member of our tear did escape and spent a year living in th wilderness in a lean-to. He was caugh when a work crew stumbled on his cam while he was out trapping his supper.

We weren't allowed access to the c blenet, so we got little news from th world outside. The water kept rising we were told, but no one gave us muc in the way of details. The local resident kept their distance from us. And so di the stream of immigrants pouring int the region from refugee camps furthe downstate.

That was our main job, of course building housing for the people di placed by the rising tide. Houses upo houses, single-family stand-alones, du plexes, apartments. And retail and com mercial space. Trees went down, lum ber rolled in, frames went up, the exteriors, interiors, and the finishin touches, and we moved on to the nex site. It was very satisfying. You could se what you'd done, see its value, and tak pride in your work. In every way it wa different from the world I'd left behin where I manipulated numbers an words and where the consequences o what I did were experienced by othe people far away.

After four years passed, I had, in mar

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ways, become a completely different person, both inside and out. I was much more at peace with myself, and I was much healthier and fit. While I'd lost my freedom, I'd regained some measure of happiness.

In the fifth year of my imprisonment, the eighth year of the flood, Peter Kelly came to me. He told me Charlie Longstreet was dead.

"The funeral was extravagant," he said. He looked much older than I remembered him. Nature had played its cruel trick on him, leaving him bald to the back of his head, but he also bore the signs of stress and responsibility. He even sounded weary.

"Lots of us kids were there. He was one of our heros. We put him in a private plot overlooking the Hudson—high on a hill, in case the water gets too deep."

"I thought his generation had been selected as the scapegoats," I said. I didn't feel very charitable towards him, considering his role in getting me where I was.

"No, that was the generation after his. The boomers are still like gods to us. Probably because most of them died before the flood."

"Rather convenient of them to do that."

"Lucky, is all," Peter said. "Luckier than you or me, anyway."

"I appreciate your coming all the way up here to bring me the news," I said. I didn't believe he was doing it out of courtesy, of course. I was just tired of waiting for him to get to the point.

"I had another reason," he admitted.

"Go ahead."

"We want to know what you did with his money."

I laughed. "I thought you took it all when you got your hands on Vermilion."

"So did we. But after Charlie died and we saw the will, we learned different. You were his lawyer. You must know what happened to his fortune. It was pretty big—everyone knows that. But there was nothing left when he went under. What did you do with it?"

I was silent a long time, long enough to make Peter nervous. "Why should I tell you?"

"We're prepared to commute your sentence. You could walk out of here a free man tonight."

I shook my head. "You kids really don't understand anyone but yourselves, do you?"

"What do you mean?"

"You know where prisons came from? They used to punish people who committed crimes by maiming them or torturing them. Then they decided that you could improve their characters by locking them up. The Quakers came up with the name penitentiary—a place where you could be penitent, where you could reflect on your sins and rise above them. It was a great idea, but it only worked for people who were capable of being penitent in the first place. And that didn't include most of your common criminals."

"So what's your point?"

"You kids made the mistake of locking up a lot of people who could repent. Present company included. What do you think I've been doing here for the past five years? What makes you think I'm willing to trade it for freedom when that means betraying the trust of a man who did nothing but good to me?"

Peter's face seemed to sag.

I could tell that this wasn't what he expected. Not at all.

"Sorry Peter, but Catholics wrote the book on sin and penance. Do you want to hear my confession? Bless me father, for I have sinned. I did not love my wife. I neglected my mother and father. I was one of the most powerful men in the world before the flood came, but I used that power for frivolous and selfish ends. I drove around in a gasoline-sucking monstrosity. I worked to keep the price of gasoline low so I could do it. I ignored the consequences of my own small actions and the greater actions of

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Vermilion. I was indifferent to a calamity that was decades in the making. I worked to convince the public that they were the beneficiaries of my own selfishness. And I enjoyed it, every minute of it.

"Maybe that was the biggest sin of all. So all I'm doing now is serving out my penance. Say three Hail Marys and spend ten years locked up in the woods. There's nothing you can do to change that. And nothing I can do either."

"I'm sorry," he said. "I thought I was dealing with a different man. I made a mistake."

"It's not your fault. The world is not what it was. Everything has changed, and we've all changed with it. I've found a new life. So have you. Maybe once, long ago, I might have taken up your offer. But I'd like to think I would have given you the same answer I'm giving you now."

He sighed, then rose to leave. "I think you would have," he said. "Otherwise I don't think Charlie would have let you work for him."

"Probably not."

"Just one question then, for my own curiosity."

"I won't promise you an answer."

"Fair enough. Just tell me if the money went to a good purpose. You didn't just piss it down the stream, did you?"

I shook my head in disappointment. "You really have to learn to become a better judge of people," I said. "Do you really think your great-grandfather would have let me do that?"

"I'm sorry," he said again. "I shouldn't even have asked."

And with that, he was gone.

Three more years passed. I moved from physical labor to management, planning the work, ordering the materials, arranging the schedules. It was still satisfying, but it wasn't the same. The time moved more quickly, though, and my boss, Martin Crossinger—the man who owned the company—came to trust me more than anyone else at the work, and gave me more and more responsibility.

And little by little, the guilt went away. It wasn't that I came to terms with it, or negotiated some release with God, or anything as clear or formal or religious as any of that. I figured I was just paying off my debt, and every day the balance was a little lower.

Then, in the spring, the news came.

Antarctica had run out of ice, and the sea had stopped rising. The world was spared.

But God, was it ever a different world.

Since the beginning, more than ten years ago, the sea had risen 148 feet and several inches. Nations had vanished. Governments had fallen. A way of life had ended. With the flooding of seaports, the global economy had become a distant memory. Chicago was the center of life and culture for America. The people of the coastal littorals had migrated to the interior, dispersing to hundreds of new hamlets like the ones I'd helped build. Even the pace of life had changed, slackening from the high pitch of the days before the flood.

And now the ragged edge of fear that we'd lived with for so many years had come to an end. The constantly rising sea no longer threatened to pour over all that humanity had built.

The euphoria was like nothing I'd ever seen.

Our celebration lasted for several days. They left the gates unlocked at our compound, though no one wandered off. They were all too intoxicated, naturally or with the help of various substances. And even when it all wore off, the world still seemed fresh and new.

A few days later a rainbow appeared at our work site and half a dozen big strong men on my crew broke down and cried. I was one of them.

Another year passed, however, before my day of freedom arrived.

I didn't expect it. They moved it up on me by a few months. Time off for good

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behavior, someone said, although I knew that wasn't done anymore. Truth in sentencing had survived the revolution.

I was just called in to the compound where a young woman—no doubt a kid back when they took over, but now past thirty—read the release and handed me the paper. Martin was there, torn between joy that I was finally free and sorrow that he was losing a trusted assistant.

I was in shock, more or less. I didn't know what to say. I didn't know how to feel. I knew it would wear off, but I didn't know when.

The woman left. I gathered up my belongings, what there were of them. I didn't know what to do. Martin offered to put me up at his house until I figured out where I was going to go, but I never got the chance.

A black car rolled into the compound, silent as a ghost with its electric motors, and pulled up before my cottage. Two young men got out, came inside, and asked if I was John Russo. I was too stunned to think of a reason to lie, so I admitted my identity.

"Could you come with us, please?" one of them asked.

"Do I have a choice?" I asked back. I wondered if this was some plot by the kids to get rid of their political prisoners once and for all.

"Utterly, sir," the other one said. "We'd be very disappointed if you didn't come with us. I'm afraid we can't explain anything more than that—those are our instructions. But we were told to make sure you knew this was entirely voluntary."

I eyed them both suspiciously. Somehow they didn't look like the kids who'd taken over and locked me up—they were younger than that. "I guess I haven't got anything else to do for the next few days," I said at last. "Or the next few years, come to think of it."

We rode for several hours through the dark Adirondack forest in a rainstorm that obscured everything behind blurred windows, until we ended up in a cramped neighborhood on some newly built waterfront. We switched from the car to a boat, rushing through the downpour and getting drenched in the process. I sat in the cabin, soaking wet, cold and uncomfortable, for another couple of hours.

The rain had turned into a foggy drizzle by the time the ride ended, at a fresh dock that emerged from the mist and the gathering shadows as evening started to settle in.

We walked down the long wooden platform, then stepped onto the muddy riverbank. We'd come ashore in some kind of park, with overgrown lawns beneath high trees. My escorts led me through the mist, up a hill to a large building of warm, red brick.

It looked like a church or a monastery, with high walls and a tower on one corner. We entered through a courtyard full of carefully maintained gardens, passed through a long chapel with our footsteps echoing loudly, and walked by ancient tapestries of unicorns, knights, and hunters. Several chapels opened off the main hall, but we continued past them and left through a smaller doorway.

We crossed the park, followed a path through the wet trees, and trudged through the woods for several minutes. Then the path broke out into a tidy courtyard where thick hedges and a wooden fence glistened from the fresh shower.

We entered an ancient farm house with stone walls and plank floors and a big porch with white railings. I could see where it had been repaired and rebuilt and where the original work remained, and I was impressed with the amount of craft that had gone into it. I could also see that the building had been moved. The signs were subtle, but clear—and they had tried hard to cover up some of the larger cracks. I'd seen enough of that sort of thing over the past few years to recognize it.

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One of the two young men escorted me upstairs to a small bedroom.

"You'll find dry clothes in the closet, sir," he said. "Something should fit you in there."

"Thanks," I said.

I stripped off my damp clothes, found a fresh shirt and pants, and put my work boots back on. When my escort returned, he led me back downstairs and out onto a wide front porch with a low roof. He offered me a seat at a heavy wooden table and pulled out his telephone.

The fog had lifted and the sky was low with swiftly racing clouds. The house blocked the breeze, but you could hear it riffling through the trees all around us. We were on a hillside, with an open view to the water in the distance.

My escort was suddenly attentive to his phone. He waited a moment, then said: "He's here."

Then he handed the phone to me.

"Hey, Johnny! What's happening, babe?"

It was the voice of Charlie Longstreet.

I was stunned. I was angry. I was not surprised.

"How do I know it's you and not some cheap AI?" I asked.

"Because no AI would know how you lost your virginity," he said. "How have you been, old pal?"

"In stir, old pal. Did you forget?"

"Beats being dead," he said.

"I heard about that. I have to tell you, Charlie, that I'm really pissed about that. For a few years now I've believed it was true. That's a lot of grief to cause an old pal."

"All I can say is I'm sorry, Johnnie," the voice said. I still wasn't convinced, but I wasn't reluctant to play along. "It had to be done that way. And it wasn't exactly a lie."

"In what way?"

"Well, they had a body to bury that any coroner in the world would identify as mine."

"Are you trying to tell me that they kept your brain alive?"

"I knew you were a sharp kid when I hired you," he said. "The institute has got me on ice, so to speak. But they let me control the chemistry. Right now, I'm doing just fine on a couple of dry martinis—they program in a memory of the taste, you know. It's one of the indulgences I allow myself after dinner. When I first went over, they gave me a month of free drugs just to see what I'd do. I went wild right up until the end. Then I quit a day early just to show them I was in charge."

"Very interesting, Charlie. I'm glad you've been occupying your time productively while I've been upstate."

"Geeze, Johnnie, I told you I was sorry once already. I know what happened to you. I know why it happened. You've got to excuse my kids—they're hard to keep in line sometimes."

"*Your* kids?"

"Just an expression," he said. "You know who I mean."

I certainly did, but somehow I knew he meant more. And that he meant to let it slip out—martinis or not.

"So why did you arrange this little meeting, Charlie? Where am I and what's going on?"

"Where are you? Don't you know? Can't you see?"

"I'm at the butt end of a long trip in a miserable storm in a farmhouse on an island in the middle of nowhere. No one has told me anything, and all I can see is rain clouds. Excuse me, things are clearing up, and I can see some buildings off in the distance."

"Look at the buildings, Johnnie. Any of them look familiar to you?"

"What? Charlie, this is an awfully strange game to be playing on someone who's been locked up for—"

Then I recognized the skyline in the distance. The Empire State Building and the Chrysler Building, and the whole crowd of midtown skyscrapers loomed halfway to the horizon—and farther off

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the twin spires of the World Trade Center. And then a wave of vertigo swept over me as I saw how high the sea was that surrounded them.

But most spectacular of all were the lights. Here and there among the tombstone-like towers were castles of light, the life inside them twinkling in the distance, their reflections dancing on the waves.

"Charlie, you son of a bitch. Why did you do this to me?"

I was on Manhattan—or what was left of it. Inwood Heights, to be specific. This porch had to be part of the Dyckman House, an old Dutch farmhouse left over from the 1600s. And we'd come ashore at the Cloisters, an art museum, not a monastery.

"I thought I was doing you a favor," he said. "I brought you home. Back to New York."

"I liked it up there. It's quiet. And peaceful."

"But I wanted to show you what happened. I wanted you to see what you did."

"What do you mean, what I did?"

"Johnnie, those are your buildings. Your whole collection. You saved them all. Every one them with their lights on is one of yours. Except for the World Trade Center, of course."

"Mine?" I squinted at the horizon, trying to pick out details. It was useless.

"And they're all running just like you set them up. Each building is an independent little unit, accumulating equity and value as time goes by. And now they're ready to start moving out, reclaiming the buildings around them. Just like you planned."

"Like I planned? Charlie, my only plan was to put your money into something that wasn't going to wash away. What happened after that was none of my concern."

"Johnnie, you're too modest. In any case, it really doesn't matter. Now they need you again. Someone has to help them out. My kids are bright, but they've got no experience at some things."

"Help them out? What are you talking about?"

"We'll talk about it more tomorrow, after you've had a chance to go downtown," he said. "There's an airfoil down at the docks for you. You'll get a kick out of it. It goes real fast."

"Charlie, I haven't agreed to anything. I'm really not interested in any of this."

"And with all your new background in construction trades? Think this through, Johnnie. It's the opportunity of a lifetime."

"I don't want to, Charlie. I don't want to do this."

"Look, Johnnie. This is your redemption, I'm offering you. That's what it's all about, you know. Sin and redemption. You sinned, you paid your penance, now be redeemed."

I was floored. He had hit the button that worked.

And he was right.

"Okay, Charlie. Whatever you say. I surrender."■

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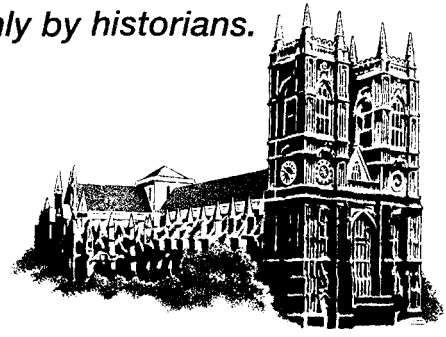
Stephen Baxter

MOON-CALF

History is read not only in history books—
and not only by historians.



This time they have a couple of hours to spare before the bookstore signing, so Jays and Alice check into their hotel, and take a walk.

Hereford turns out to be a small, picturesque little town like so many others crowded into England. It is incredible to Jays that they are only a hundred thirty miles west of London, and yet they've already all but come out of England into Wales. The centre is pretty, with a lot of historical curiosities, some of them incredibly old—"Nell Gwynne was born here," Alice points out, "I thought she was a character from a novel"—but it is a little clogged with traffic.

The older houses are built of old red sandstone, Jays recognizes.

They walk along a river called the Wye. It is a steamy June afternoon. Today, in fact, is the longest day of the year—with the sky a high, pale blue dome, and the reflection of the cathedral shining in the water. But the river is running low, and the willows are having trouble dipping to the water surface, and the grass sward is long and yellow, for England is suffering another of its baked-dry summers. The climate is changing here, with Mediterranean weather patterns working their way up from southern Europe. But, Jays remembers, England always looked pale brown or grey, not green, from orbit.

At around five, they walk into the cathedral. A choir of schoolboys is practising, and their thin, delicate voices float on the air. There are tourists here but they move around quietly, looking up. Jays is conscious of the loud click of the toecaps of his boots on the flags.

Alice reads aloud from a guide pamphlet. "'The cathedral is mainly Norman.' Some of it is 900 years old, Jays 'Of special interest are the carved stalls the fourteenth century Mappa Mundi in the south transept, the chapels, the tombs and the library, with its chained and rare books.'" She sniffs. "I'm becoming acclimated to all this great age, I think."

Jays runs a hand over a huge slab of sandstone embedded in a pillar. Somebody has carved a graffito here—'Dom. Gonsales'—but even this desecration is self-evidently ancient.

"Nice rock?" Alice asks drily.

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Jays grins as they walk on. "Actually, yes. This is Devonian sandstone—"

"Don't tell me. When dinosaurs ruled the Earth."

"Hell . . . Much older than *that*. This stuff is about four hundred million years old, Alice. We're on the coast of the Old Red Sandstone Continent. The rock here was laid down in lakes and deltas; most of southern England was covered by ocean. There were plants on land, but no animals yet. . . ."

She nods as if listening, but she has found a small book stall, and is starting to browse.

Jays scratches the frosting of white that is all that is left of his hair. He is now seventy years old, fit and California-tanned. For twenty-five years since his Apollo flight—his one and only spaceflight—he has been a bore about the Moon. And now his interest in geology is making him a bore about the Earth, too.

It is kind of heroic, he thinks, to be dull on two planets.

Alone, he wanders a little further. He tries to fix the church in his memory.

Most of the great English cathedrals stopped developing during the Reformation in the sixteenth century, when Henry VIII took his country away from the Church of Rome. Compared to the great churches in Catholic countries like Spain or Italy, swamped by centuries of ornamentation, English cathedrals have a certain austere class, he has decided.

He comes to a small, rather ugly side chapel. It isn't roped off, but there are no tourists here. The walls are much darker than the rest of the church, and that, together with the filtering of the light by a couple of niggardly slit-windows, adds to a sense of gloom and age.

Jays, on impulse, steps inside. There are a couple of pews before a small, nondescript altar and a stand of unlit candles. There is dust on the pews. A paper sign, stuck to the wall with putty, tells him this is Bishop Godwin's Chapel, XVII Century. So this chapel is older than his nation. The windows are filled with panes of stained glass, which show what look oddly like Chinese scenes.

He runs his hand over the wall. Maybe the dark coloration is candle black, he thinks. But his fingers come away clean, save for a little dust.

He decides to apply a little geology. It looks more like an igneous or metamorphic rock than a sedimentary, like a sandstone. It is dark and isn't coarse-grained, so that makes it a basalt. And there are fine gas bubbles embedded in the surface. A vesicular basalt, then—a lava that has cooled on the surface of the Earth.

He looks around. The chapel's walls are all constructed of the dark basalt.

A lava, here in the heart of Britain?

He looks around, but there is no leaflet to explain the chapel's history, nor anybody to ask about it.

Alice is still in the bookshop, leafing through a pamphlet.

"Hell of a thing," he says.

She smiles abstractedly. "Look at this. It's about you." She passes him the little book.

It is called *The Man In The Moone, or a Discourse of a Voyage Thither by Domingo Gonsales, the Speedy Messenger.*

The story is about how a man called Gonsales trains swans to carry him through the air. Twenty-five of them, each attached to a pulley, save him from a shipwreck. But the swans hibernate on the Moon, and carry Gonsales there. . . .

And so on. It is a seventeenth-century tale, he sees, reprinted by some local enthusiast. The kind of stuff they now call proto-science fiction.

Domingo Gonsales. He tells her about the graffito he saw. She takes the book back. "Maybe it was a fan. Or a literary critic. What did you want to tell me?"

He describes the lava walls to her. "It's just it doesn't make any sense, geologically."

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She pulls a face. "*Geology,*" she says. She has a broad, high-cheekboned face, highlighted blond hair and intense blue eyes. At forty-five, she still turns heads. In a way he is glad she is getting a little older. It makes him less open to the accusation that he's picked up a trophy wife, after Mary dumped him. And Alice has turned out to be one hell of a PA and agent, as his modest literary career has taken off.

"Remember what I told you. You can tell the geology of an area just by looking at the old buildings there. . . ."

Once, most of Britain was covered by a shallow ocean, which deposited gigantic chalk layers. But then Britain tipped up, and the ice came, scraping most of the chalk off the top half of the island. Now, as you travel south from Scotland, you traverse younger and younger landscapes: billion-year-old gabbros and granites and basalts in Scotland, belts of successively younger sedimentaries as you come down through England, until you reach the youngest of all—the marine Pleistocene clays and sands around London, less than sixty million years old.

His signing tour has taken in Aberdeen, Edinburgh, Preston, Manchester, Birmingham, Peterborough, as well as London. He's insisted on taking a train or a hired car everywhere—never flying—so he could see the old buildings—churches, houses, pubs, even railway stations—which stand like geological markers, constructed of the native rock. . . .

"Anyhow that's why the basalt in that chapel is so odd," he says.

"If it is basalt."

"Sure it is. Come on, Mary—I know basalts. All the damn Moonrocks we picked up were basalts. It's just unusual for such an old building to feature such displaced materials. They didn't have the hauling capability we have now."

She shrugs. "They built Stonehenge from that rock from Wales, and that's a lot older. It's just a few tons of some Scottish stone."

"But what the hell's it doing here, in the Godwin Chapel?"

"Godwin?" She frowns at that, and looks again at the book she is holding. According to the jacket *The Man In The Moone* was written by Francis Godwin, Bishop of Hereford, in the seventeenth century. "How about that," she says. "You suppose it is the same guy?"

He shrugs. "We could check."

She reaches for her purse. "Anyhow, this settles it. I thought nine pounds is a little steep for forty-three pages, but I guess this book has been waiting here for us to find it."

She pays for the book, and he wants to go back to the chapel, but there is no time left before the signing.

"*So, Colonel Holland, why 'Jays'?*"

It is a question he's answered a hundred times before, but what the hell. "It was my sister. When she was a kid she couldn't say 'James' right. It came out 'Jays'. It stuck as a nickname."

"*Is it true you changed your name by deed poll to Jays?*"

"No. And it's not true I trademarked it, either . . ."

Laughter.

The little lecture room in the back of the book store is maybe half-full, rows of faces turned to him like miniature moons, filled with pleasant interest. He decides he is going to enjoy the event, even if he feels intimidated by the giant show cards his publisher has sent over from London—"*Rocky Worlds*—A Vision of the Future by a Man Who's Been There . . ."

"*Why the title?*"

"Something that occurred to me on the Moon," he says. "Maybe Earth is unique. But the Moon isn't, even in our Solar System. The Galaxy has got to be full of small, rocky, airless worlds like the Moon. Right? I was only a quarter million miles from Earth, but if I looked away from Charlie and the LM, away from the Earth, if I shielded my eyes so I could see some stars, I could have been anywhere in the Galaxy—hell, anywhere in the Universe. . . ."

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The audience moves subtly, showing he has hit the wonder nerve. Even though he's cheating a little. He had no time for such reflection on the Moon; such insights have come from polishing those memories in his head like jewels, until he can't tell any more what was fresh observation on the Moon or the maundering of an old man.

Sitting here, his hands flapping like birds in front of him in his nervousness, he knows how he comes across: he is a retiring, almost inarticulate man. Hell, he is just a pilot after all—who has been thrust forward by history and has made himself articulate.

"Your books are full of geology. But you weren't trained in geology for your Apollo flight."

That isn't quite true. They'd had some training from geologists attached to the project—they'd be taken to Meteor Crater, Arizona, or some such place, and told to *look*—they had to try to be geologists, at least by proxy, in a wilderness no true scientist had ever trodden, and maybe never would.

But in the end it came down to completing the checklist, and wrestling with unexpectedly balky equipment; and anyhow, the LM put them down on a *mare* which turned out to be a dull lava plain. . . .

. . . a plain that shone, tan brown and green, beneath a black sky, with a surface that crunched beneath his feet like fresh snow, rock flour impact-shattered by three billion years of bombardment, pocked with craters of all sizes from yards across to pinpricks, and he remembers how he pushed his fingers into the surface, monkey fingers swathed in white pressure suit gloves, but he came up against stiff resistance a few inches in where the impacts tamped down the regolith to a greater density than any compacting machine could achieve, and when he pulled out his hand his glove was stained coal black . . .

But such moments were rare, as he spent three days bouncing across that bright, sandy surface with his commander in the Lunar Rover, wisecracking and whistling and cussing; for the point of the journey was not the science of the Moon, of course, nor even the political stuff that pushed them so far, but simply to get through the flight with a completed checklist and without a screw-up, so you were in line for another . . .

But for him, there never *had* been another. After returning home he was caught up in the PR hoopla—stuff he'd hated—stuff that led him to drink a hell of a lot more than he should have. And by the time he'd come out of *that* he found himself without a wife and out of NASA, and too old to go back to the Air Force.

It was a time he thinks of as his Dark Age.

But he kept in touch with the studies of the Moon rocks he brought back. It prodded in Jays a lingering interest in geology. He took a couple of night classes, and did a few field trips. For a while it was just a way to fill up time between Amex commercials and daytime talk shows, but he has soon come to know a lot more about his home planet than he ever did about the lonely little world he, and only eleven other guys in all history, have visited. Hell of a thing.

And gradually, the geology stuff has hooked his imagination.

Death Valley, for instance: if you manage to look beyond the tourist stuff about bauxite miners and mule trains, what you have there is a freshwater lake teeming with wildlife and flora that has gotten cut off from the sea. Over twenty thousand years the lake dwindles and becomes more and more saline; the trees and bushes die off and the topsoil washes away, exposing the bedrock, and the lakes' inhabitants are forced to adapt to the salt or die . . .

His first short story is slight, a tale of a human tribe struggling to survive on the edge of such a lake.

Nods, from the SF enthusiasts in the audience. *The Drying.*

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It sold for a couple hundred bucks to one of the science fiction magazines, he suspects for curiosity over his name alone. A novel, painfully tapped into a primitive word processor, followed soon after. He hadn't read SF since he was a kid, and now he rediscovered that sense of time and space as a huge, pitiless landscape that impelled him towards space in the first place.

A couple of books later his sales dwindled,when the celebrity angle wore off. But then they started to pick up again, and he is pleased with that, because he suspects people are starting to buy his fiction for itself, not because of *him.*

He doesn't say all this to his audience, however. But they probably know it. His life is a matter of public record, after all.

"*Are you arguing for a return to space, in your books?*"

"I guess so. I think we need to be out there. You don't need to know much geology to see that . . . in a few thousand years the ice will be back, scraping the whole damn place down to the bedrock again, and I don't know how we're proposing to cope with that. And then there are other hazards, further out. . . ."

"*The next big rock. The dinosaur killer.*"

"It's on its way, maybe wandering in from the Belt right now, with all our names written on it. . . . But I'm not propagandising here. This is just fiction, right? I want your beer money, not your vote."

Laughter.

"*Do you feel bitter about the big shut-down that happened after Apollo? Do you blame the Confucians, or the eunuchs?*"

That question, from a little guy in a battered anorak, throws him. But he remembers that odd Chinese-looking design in the stained glass in that peculiar chapel, and he wants to pursue the point. But the little guy starts to lecture about the Ming Dynasty, and the bookstore owner moves them on.

After an hour or so, the owner winds up the Q-and-A. He signs maybe a dozen copies of the new book, and some stock, and a couple of battered paperback editions of the older stuff.

Before dinner, the store owner takes them to a pub called the *Wellsian.* "I thought you'd like to see this. . . ." Bizarrely, it is an H.G. Wells theme pub, with mock-ups of a Hollywood Time Machine and Martian tripods stuck over vaguely Victorian decor. There is a bar menu which, though containing the usual bland rubber-chicken options, nevertheless has each dish referenced to Wells: "H. G. Tagliatelle," or "Herbert George's Chicken Kiev," and so on.

He has his picture taken under an engraved line from *First Men In The Moon*, about a moon-calf—a word which, the bookstore guy tells him, is actually an old English word meaning something like blockhead, and which gives him an opportunity for more gentle joshing.

Alice seems to be trying not to laugh. "It's the weirdest place I've ever seen," she says. "H. G. Wells had nothing to do with Hereford."

"Nor does basalt."

Jays accepts a diet soda. The little guy from the Q-and-A, who'd talked about China, is here, cradling a pint of some flat English beer. His name, it turns out, is Percy; he is aged maybe fifty, and he works with the Cathedral's collection of rare books. His clothes have a vaguely musty smell, not necessarily unpleasant. When he speaks his voice is something of a bray, and the other locals tend to look away and change the subject; he is evidently something of a local eccentric.

Nevertheless he isn't bugging Jays, and he seems to know all about China. Jays lets him open up about his eunuch reference.

Once, says Percy, the Chinese led the world in technology: they had printing, gunpowder, the compass—in some cases centuries before Europe. At the time of the early Ming Dynasty, in the

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:arly fifteenth century, they even went :xploring.

They built 1,500-ton "treasure ships," :ach big enough to carry five hundred nen. Chinese explorers rounded south-:rn Asia to Bengal, Ceylon, and even eached the east coast of Africa in 1420,)redating the Portuguese expeditions by ifty years. The ships brought home exot-: novelties—people, animals, plants—nd struck terror wherever they landed.

"The great voyages were led by Admi-al Zheng-Ho," says Percy, "who was a unuch. But in 1436, a new emperor ame to the throne, called Zheng Tung. le cut the building of ships, the con-truction of armaments and so forth. he navy fell apart, and China was iso-ated from the rest of the world until the arbarians from Europe came sailing up our centuries later. There are obvious :sonances for our times. . . ."

"Yeah," growls Jays.

"The cause of it all was conflict be-ween the Confucian scholars who ran ie imperial bureaucracy, and the Grand unuchs of the Imperial Court. The eu-uchs' voyages were seen as a threat to ie bureaucracy. But the Confucians /ere in charge of educating the emper-r and they had played a long game. hey had convinced the young Zheng ung that China was self-sufficient, and idn't need to deal with the barbarian nds at its rim. So they blocked techno-)gical development, to maintain their :udal power. . . ."

Some of the other fans, sensing the nplicit approval Jays is bestowing on ercy, are edging closer. They start to)eculate, as Jays has learned fans will o, about what-if parallel universes in 'hich the Chinese kept going. Perhaps rancis Drake would have faced an Ar-ada of Chinese treasure-ships. Perhaps heng-Ho might have reached America efore Columbus. And so on.

Jays asks Percy what happened to heng-Ho. He shrugs, almost spilling the eer he has barely sipped. "There are sto-es that he went off to the hinterland and tried to keep exploring, with technologies out of the grasp of the bureaucrats. China is a big country, after all; there was room for such things. And for a lot of legends. Zheng had followers, who are supposed to have kept up the work after his death, until the Confucians closed them down. It's probably all apocryphal. Man-carrying rockets, for instance."

There is general laughter at this, and there is more speculative chatter about a Chinese space program of the fifteenth or sixteenth centuries.

Jays is reminded of what he once knew of the history of rocketry. The Chinese developed the first rockets around the year 1000 AD, under the Sung Dynasty: the versions that leaked to Europe via the usual trade routes were just crude affairs, gunpowder-filled bamboo or pasteboard tubes with little power and unpredictable trajectories. . . . Still, reflects Jays, in the heart of China, there might have been five centuries of development of this technology by Zheng-Ho's day.

There is also, it seems, a Chinese legend local to Hereford: of a sixteenth-century traveller from Spain who came here with what sounds like a goods caravan, laden with exotic jewelry and herbs—all, he claimed, from the heart of mysterious Cathay.

Oddly, he also brings rocks.

The tale is recorded in the Godwin Chapel's stained-glass window. And some of the locals remember the incident by keeping up an old tradition of a festival held on the fifteenth of August, celebrating the day a Chinese goddess was supposed to drink a magic elixir and fly to the Moon. There are invitations for Jays to come back on the fifteenth of August, a couple of months away.

Alice has finished her white wine spritzer, and is discreetly plucking at his sleeve.

They make their farewells and apologies, and escape into the cooling air of the evening.

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In the pub garden, a wood-fire barbecue is burning; wood to make this cultural import seem more traditionally English, he guesses. The smell of the wood takes him right back, across twenty-five years. . . .

. . . after the first moonwalk, when the oxygen had rushed back into the aluminum balloon that was the LM's cabin, and both of them were covered in grime; when Charlie took off his helmet, and Jays took a picture of his smiling, lined, bearded face, and then of the area outside, the flag and equipment and the parked Rover and footprints everywhere, footprints that might last a million years; and when he took his own helmet off, there was a pungent smell, the odour of wood-smoke, or maybe of gunpowder: it is the smell of Moondust, slow-burning in oxygen from Earth . . .

But it is time for dinner with the publisher's rep, and they walk on.

In bed, Jays glances through the Godwin book. It is a comedy—he guesses—lacking the gloss of modern science fiction. But some of the ideas seem reasonably sophisticated for its time. The good Bishop was a little mixed up about the size of the stars, but his universe was Copernican—with the planets circling the Sun—and he got gravity more or less right, with references to different gravity on the Earth and Moon, weightlessness between worlds, and the problems of reentry to Earth's atmosphere.

Jays has read, or rather discarded, some modern hard SF which contains worse bloopers.

He describes all this to Alice. "It's hardly a traveller's guide," he says, "but . . ."

She takes the book from him and kisses him on the cheek. "You're very sweet, but very transparent. You'd love it to be true, wouldn't you?"

"What?"

"I could see what you were thinking, in that ridiculous pub. Maybe the Chinese went to the Moon, in the fifteenth century. Maybe the story somehow reached England—here, Hereford—perhaps through the traveller they talked about."

"And maybe Bishop Godwin wrote it up."

She leafs through the book. "But why not just tell the story straight? Why all this stuff about swans? Why not just write about the Chinese admiral and his rockets?"

He shrugs. "Because he couldn't be straight. Just as I write science fiction rather than documentary." It is true. His autobiography was actually ghosted. They have had discussions like this before, prompted by reviews and analysis of his work.

"The analogy doesn't hold," she says. "You did something extraordinary, something no human had done before. And you weren't trained to describe it. Not even to observe. No wonder you write your books. It's your way of working it out in your own head."

He shrugs. "It was that, or find Jesus like the other guys. Anyway, my point is nobody would have believed Godwin. Think of the context of the times. Nobody believed Copernicus, for God's sake. Maybe Godwin didn't believe it himself.

"*I* don't believe it. Listen to this. Gonsales finds an inhabited Moon, and the creatures live in a Utopia and are superior to us. Of course. And they weed out any who fall short of the mark, and throw them off to Earth. . . . 'The ordinary vent for them is a certain high hill in the North of America, whose people can easily believe to be wholly descended from them. . . .'"

He laughs. "Damn these Brits. Ungrateful even then. What happens to Gonsales in the end?"

Alice flicks through the book. "The Moon prince gives him jewels, he sets off for Earth with his swans . . . and lands in China, where they lock him up as a magician." She throws the book down. "China. And I hope you're not going to read anything into *that*. I'm going to throw this damn book awa

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You're obsessed, Jays. You look for Moon stories that don't exist. I don't blame you. But it's the truth. You're a Moon-calf . . ."

She turns her light out.

It is many hours before he can sleep.

He has to go to the bathroom in the middle of the night. It is an old man's thing. He tries to float out of bed, and falls to the floor, heavy on the carpet. This has happened before.

The next day is their last in England, and they have to take a train into London, then the Tube back out to Heathrow.

Jays gets up early. Without waking Alice, he slips on his track suit and sneakers, and runs out into empty streets. Squat electric carts are delivering milk, whirring along the streets, making a noise that reminds him of the prototype Lunar Rovers he saw under test at Boeing.

He jogs until the air, already hot, is whistling in his throat.

He reaches the cathedral. It is locked up, and he is disappointed, but he discovers he can work his way around the outside. He quickly finds the Godwin Chapel. It is hard to miss—a dark, grimy encrustation on the cool sandstone of the cathedral.

He runs his hand over the exterior of the rock. It is heavily weathered, of course, and encrusted with lichen. But its vesicular nature is easy to confirm, in the bright morning light.

He knows that lunar basalts, formed when the great primordial impact basins were flooded with lava, have a lot in common with terrestrial lavas—they are mostly feldspar, pyroxene, olivine and ilmenite—but there are key differences too. Lunar rocks possess native iron, for instance. They have been subjected to shock damage from micrometeorite impact, and to radiation damage from solar wind and cosmic rays. They have some trace elements, such as hydrogen, carbon and nitrogen—implanted there by the solar wind. They contain no water at all. . . .

He wishes he could take a sample. But he has no tools. And who would run the assay for him? He works his way around the chapel, running his hands over the surface.

He finds that a chunk of the chapel wall, a fist-sized pebble, has broken away from one corner. The pebble is just lying in the grass.

He cannot tell if this is frost damage, or perhaps vegetative, or some minor piece of vandalism.

Guiltily, he slips the pebble into his pocket.

On the train to London, with the two of them facing each other surrounded by luggage, he toys with the pebble.

"Scottish basalt," Alice says.

"Sure."

"You should be ashamed." She is laughing, but he senses she means it. "If every American tourist came away with trophies there'd be none of England left . . ."

He knows she is right. He does not want to keep this piece.

She calls him a Moon-calf again.

He waits until she has gone to the buffet for a fresh coffee. He glances around; nobody can see him.

He has a full can of diet soda. He rests his rock, on a newspaper, on the tiny British Rail table that is fixed to the wall before him. He smashes the rock with the base of the can; the rock cracks open.

As the interior is exposed to the air for the first time, there is a smell like wood-smoke.

He breathes it in for a few seconds. Then he brushes the fragments of rock into the palm of his hand, and dumps them out the window. The rock is scattered along the track and lost; he brushes the last grains from his hands.

When Alice returns, London is approaching—modern suburbs crowding out the ancient English landscape. They start to talk about the flight home, checking tickets and terminals and passports. ■

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THE GOLDEN AGE OF ROCKETRY

It has been said and believed by many, myself included, that the Golden Age of Science Fiction for any man is when he was twelve, thirteen, and fourteen. I think this is also true for the Golden Age of Rocketry, at least among those of us guys who came of age during the middle of the twentieth century. Now I've already used two noninclusive words, "man" and "guys", and no doubt some of you readers are already annoyed. But I don't know when the Golden Age of Science Fiction occurs for women, and I don't know any women who built their own homemade rockets from scratch (which is what much of this column is about) in the 1940s and 50s. (That's a hint—any woman out there who built and launched her own homemade rockets, or who belonged to a local rocket club, please write and tell me your story—I'd love to hear it.)

The opening chapter of Heinlein's *Rocket Ship Galileo* has always stuck with me: a group of boys building and flying their own rockets; testing fuel combinations; suffering the rite of passage of the inevitable explosions. How romantic it seemed when I first read it. How romantic it still seems today!

I recall two of my physics professors once talking over coffee about the rocket one of them built. The first told of how he and his buddies made the rocket out of pipe, and how it exploded about ten feet off the pad. "You made it out of *pipe*? And you thought *that* would fly?" the other hooted. "Well, it *did*!" came the reply. "*Parts* of it flew a quarter mile or more!"

One particularly delightful accoun I've read about groups of boys buildin rockets came from Homer H. Hickman Jr. in an article entitled "The Big Creel Missile Agency" appearing in the Febru ary/March 1995 *Air & Space Smithson ian* magazine. Therein he describe how Sputnik was launched when h was fourteen, how he and his friends de cided to build their own rockets, an how their first attempt blew up thei fence. They learned how to make fuel that would burn at the right speed, hov the nozzle design had to be optimized and the importance of range safety. Onl a few years later, Mr. Hickman and hi friends who made up the Big Creek Mi sile Agency (BCMA), to much fanfar and with many of the miners and thei families of Coalwood in attendance launched the *Auk XXXI*, a bird five fee tall that climbed to four miles.

Ah, *those* were the days!

But I was born half a year before th flight of the *Auk XXXI*, and didn't tur twelve until 1971. I also lived in the sul urbs, and there was no place to conduc rocket experiments along the lines c the BCMA, let alone launch a rocket t four miles altitude. (At least, not an where close enough that I could ride m bike to.) Add to this the fact that I ha no friends in my neighborhood wh were even remotely interested in formu lating rocket propellants and assaultin the sky.

But there were these things calle "model rockets", made out of cardboar tubes and balsa wood. They wer launched from a plastic stand wit prepackaged little engines that woul

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not only put the rocket into the sky, but pop out a parachute to bring it back safely. The rockets came in kits with directions and a boy or girl could build and launch the things without having to learn any of the stuff the boys in the BCMA had to find out via trial and error. Almost any parking lot or football field could support a "launch facility".

I'm sure many of the old guard, who made their own fuels and did their own tests—who made rockets out of metal, dammit!—would think that rocketry with cardboard tubes and store-bought engines was but a pale imitation of what they did. Perhaps in some ways they're right. But if I'd blown up a fence while experimenting with rocket fuel, that would have been it for my excursion into rocketry—my Mom would have put a stop to it.

I have a question for the old guard: How many of you were able to build multi-stage rockets? More questions: How many of you were able to build boost gliders? How many of you were able to vary your designs from the basic "rocket" look?

You see, although a great many kids lived by the designs of the rockets that came in the kits, I was not one of them. Having mastered the principles of rocketry in short order, I decided that the real fun lay in designing my own rockets. I started ordering supplies in general—tubes, balsa wood, nose cones, shock cords, parachutes. I had my folks get me a lathe for Christmas so I could turn my own nose cones.

I made a rocket that looked like an Egyptian obelisk.

How many of you folks in the old guard made yourselves a square rocket, eh?

Many and fond are the memories I have of those days. What I remember most from eighth grade was how fast the dreary hours of school would pass while I sketched dozens of different patterns for rocket fins, and conceived of rockets that I would build, and others that maybe I would build if only I had the money. My mind ranged widely. Though I'd be hard pressed to name more than a dozen or so of the classmates I had in Junior High, I can still draw out every detail of the designs I worked out for building a balsa wood flying saucer. It would have had three engines in a flared cluster, twisted a bit to induce rotation. I planned to include plumbing inside, so that not only would the parachute deploy, but some shunted ejection gases would also make landing legs pop down, just like on the *Jupiter 2* from *Lost in Space*.

I never built that flying saucer, but I still may someday.

You see, by simplifying and standardizing one aspect of rocketry, thereby making it both a safer hobby and available to a lot more kids, this allowed for a great deal more exploration and experimentation into how varied one could make a rocket and still have it fly. Sure, I never got to blow up the fence—but I do think taking my own designs out into the backyard and swinging them around on the end of a string to see if they'd tumble or fly straight was certainly a form of experimentation every bit as fun as mixing up different kinds of chemicals. And sure, I never really worried about a rocket blowing up (although sometimes an engine would be defective and blast upward through the rocket body—it was hell on the parachute, but not on much else), but I most certainly worried when a first stage would fail to ignite the second. *That* kept me watching the sky for a few seconds until I saw where the upper stage streaked to destruction on the ground. (There was another time when a short, two-engine clustered rocket, my own design, almost took out my entire eighth grade class—only one engine ignited, and it went up maybe ten feet, pinwheeled around, then tore itself apart on the ground when the ejection charge went off.)

Many of you know that G. Harry Stine was the one man largely responsible for making model rocketry the hobby I

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enjoyed, and the one it is today. Many of those rocket builders who turned fourteen before 1962 or so likely lament what the hobby lost because of Stine's work. The lament has a certain legitimacy to it, but I think it's entirely outweighed by the number of fingers still attached to hands that might not otherwise be if G. Harry Stine hadn't helped separate the power plant from the rocket proper.

And there is another matter to consider. G. Harry Stine wasn't responsible for stopping anybody from making his own rocket fuels. Though getting started in model rocketry became something that would begin with a trip to the hobby store for a suitable starter kit, there was never anything to prevent a kid from making a trip to the library to learn about mixing his own fuels. Pipe was still in good supply, and for that matter, those ignition systems from the model rocket kits could be easily adapted for launching missiles made of steel.

Just because there are elevators doesn't mean you can't use the stairs. Just because there arrived a safer form of rocketry, didn't mean you couldn't still risk blowing your fingers off. So nothing G. Harry Stine did killed off that "romantic era of rocketry", that Golden Age. But it did allow another, safer era to arrive for thousands of kids who otherwise would have had to do without.

I told you I once built a rocket that looks like an obelisk. I never launched her, though. I loved her too much to risk her. She rests on a closet shelf in my old room at my Mom's house, awaiting the day I find a suitable place for her in my home. But perhaps she's safer there. You see, I still think about her, even when she's out of sight. Sending her on her maiden voyage remains as the last bit of meaningful unfinished business I have left from my youthful years. If I see her every day I don't know if I'll be able to resist the urge to finally send her into the sky. She may turn out to be unstable. Her funny shape may cause her to crash, and then she'd be nothing more than a mashed morsel of memorabilia.

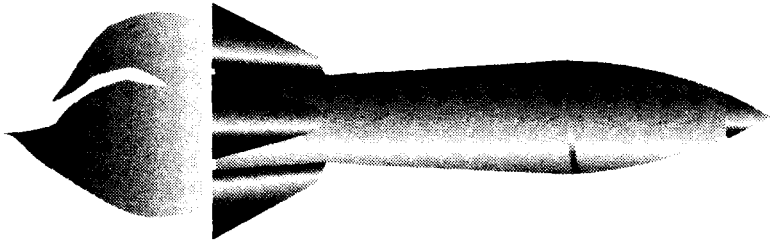
But if she flies well—oh, what a glorious blast(off) from the past that would be!

It was a sad day when Stan called to tell me that G. Harry Stine was dead. I owed him so much for making rocketry possible for a young boy growing up in the suburban '70s, even before Stine began doing regular columns for *Analog*. It was seldom that I failed to learn something worthwhile from Stine's Alternate Views, and I can honestly say that some of the opinions I cherish today came directly from him.

I very much enjoyed doing pinch-hit columns during Harry's absence. I hoped that those columns would give me experience writing short nonfiction pieces, and that one day when G. Harry Stine decided to retire from his column, he'd write a farewell piece at the end of which he'd welcome me into his seat.

Now that can never happen.

I'm the new, regular Alternate View columnist now. Jeffery D. Kooistra, a man of alternate views—if any phrase sums me up that pretty well does. I know I can never fill the big shoes that G. Harry Stine wore. But I do hope to be able to follow in his footsteps, and blaze a few trails of my own.■



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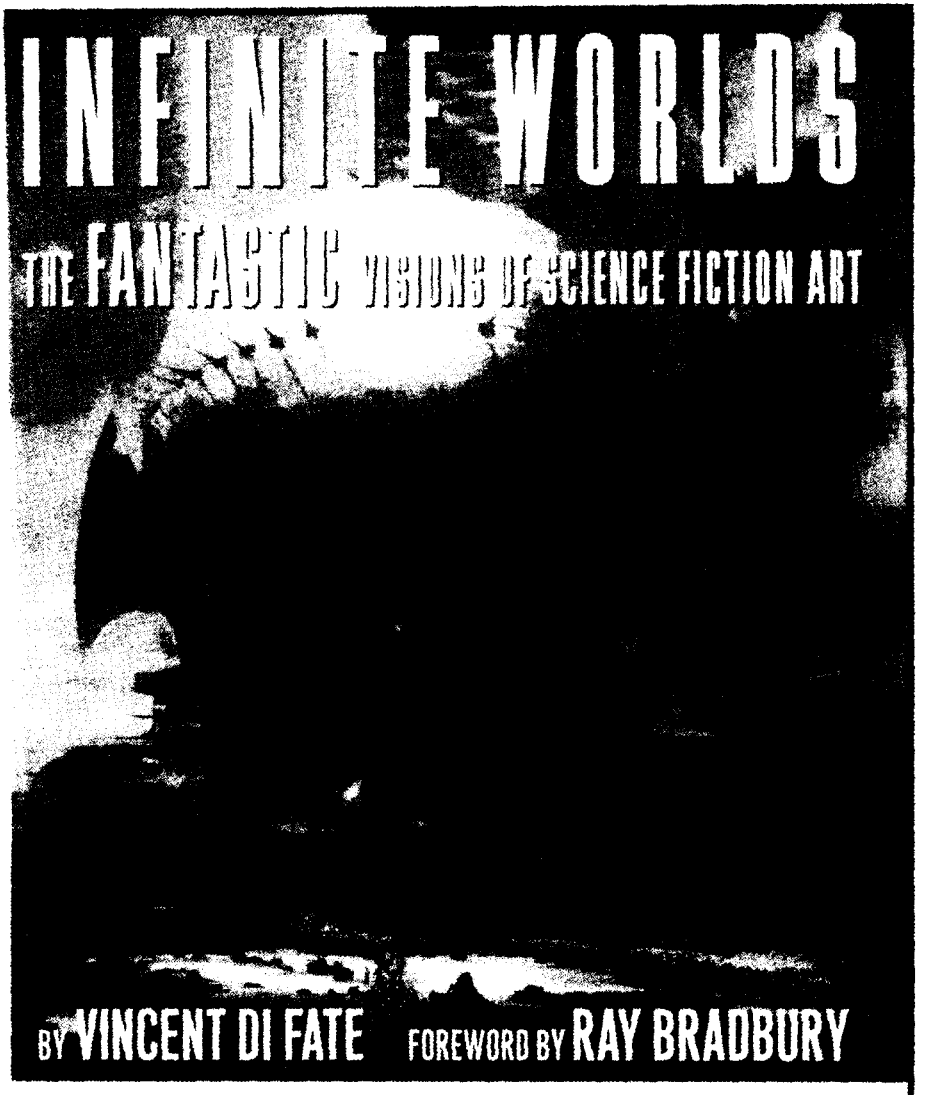

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Shane Tourtellotte

THE LONG WAY HOME

When you're running some races, it's easy to forget what your real goal is. . . .

Douglass Taliaferro groggily pulled himself into the bridge of the *Armstrong* against the tug of one-tenth *g* deceleration. He had been asleep for twenty-four years, and as captain, was awakened some hours before the other three crewmembers. Fifty years to Alpha Centauri and back, and now Earth was two hundred million kilometers distant. One week away. Unimaginably close.

First things first. He transmitted a message to Earth, one he had composed before entering cryostasis, announcing their return. He appended a thorough upload of their data banks, all the information they had gathered on their mission, including a detailed inventory of samples.

He didn't include his subordinates' actions in the last days before leaving Centauri. No real use. They had lost enough already.

As the message went out, he began a long, pleasantly numbing checklist. Near the end, he looked at computer logs of course corrections during their return leg. He expected to see one big one early on.

There were five.

Taliaferro hung loosely in his seat harness for a moment, absorbing what that meant, wondering what the others would think. Suddenly, the board chirped with an incoming message. It was their command center, replying even while *Armstrong*'s upload continued.

He put the message on screen, surprised that anyone cared any more. Not after *Tsiolkovsky* changed all their plans. . . .

Scott Kroft's voice came through the intercom. "I said, may I take manual control of the sensor arrays, Captain? There's something I want to check out."

"Go ahead." Taliaferro turned back to the two men crammed into the bridge with him. "Rich and famous, you were saying?"

Russell Rearden nodded forcefully. "Don't tell me neither of you have thought about that. Speaking fees alone should keep us well-off for life. It better. I'm not spending fifty years in stasis for nothing."

"John may steal your thunder, Russell. Geology did fine, but biology hit the jackpot." Their scout had thrusted out of orbit a day ago, to rendezvous with

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Armstrong's main drive. Behind them was Alpha Centauri A's second planet, a living world. Not as teeming as Earth, but no less wondrous. "So, John, how will you spend your millions?"

John Hu's baby face flushed, either from embarrassment or freefall nausea. "I'll probably go back to school, get a degree in geology. No, seriously. Doing this field work, you start to understand how soil compositions, erosion patterns, volcanism can affect biology. I've had a good teacher for that, even if he is planning early retirement."

Russell held up his hands. "Don't get me wrong, John. I'll stay in the field—someone has to explain all our data to the rock-jockeys back home—but I'll do it on my terms. We'll all be able to do whatever we want with the rest of our lives. Nothing wrong with that."

"No, suppose not. What about you, Captain? What are your plans when we get home?"

Kroft appeared behind Taliaferro before he could speak. "Captain, someone's coming!"

They replied as one. "What?"

"There's a—a—let me show you." He squeezed between them, to reroute the real-time data from his engineering station. "There's an intense gamma ray source entering the system. The flare bunker wouldn't slow it down if it were pointed at us, but it isn't. There's a thin matter stream accompanying it."

Kroft put a graph on a secondary monitor. A huge spike erupted from the flat line at the left, with several minuscule ticks after it. He magnified the stretch of ticks.

"The big spike is a helium signature. The twins are helium-3 and tritium, helium-3 more common. Those little scratches are deuterium and lithium-6."

"Those sound like fusion residua," Rearden said, "and that first spike must be hydrogen."

"They are. They're exactly what I'd expect from a hydrogen fusion engine." A beatific wonder glowed in his face. "Regular hydrogen."

A long moment of silence stretched after that. "Where's it coming from?" Taliaferro finally asked.

Kroft replaced the isotope display with a chart of the Centauri system. A projected track pierced the ecliptic from far above. Perspective shifted, swinging the track into an edge-on dot, which then winked out. In its place remained a bright yellow dot from the background starfield.

Kroft didn't name the star, or the planet. They all knew.

"Nobody said they were sending another," Rearden objected. "Do you suppose Houston thought we were lost?"

"They couldn't build another ship in two years," Hu insisted, "not with all the bureaucratic failsafing ours had."

"How distant is it?" Taliaferro asked. "When will it arrive?"

Up went another display. "About four light-hours. Three months of deceleration, if this were our ship—but it's not. Give me time to pin down its delta-vee, then I can give you a real number."

"Please do that," said the captain, his resonant voice unusually faint.

Rearden knocked off his cataloguing duties early in ship's night, and went to get rations. He carried his heated box from the mess, down a spoke ladder and into the ring, which was spinning again after their boost from orbit.

"Got a minute, Scott?"

Kroft glanced up from his own dinner in the engineering niche, and grunted softly. Rearden sat nearby. "What's the word with our guests?"

"There is none. They've had two days to respond. I have their position, velocity, and delta-vee nailed; our signal couldn't miss. Maybe they aren't listening for us, but why shouldn't they?"

"Hibernation?"

"Ship's computer could respond for them."

"Yeah." Rearden waited a measured moment. "Are you sure about those numbers?"

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Kroft eyed him coldly. "The captain and I triple-checked them all. They're right."

Rearden whistled softly. "Six years. A quarter of what we took. That doesn't count time dilation, either. They might not have needed hibernation."

Kroft said nothing, giving a long scroll of numbers his attention. Rearden edged closer. "Scott, it isn't right."

"I said the numbers checked out."

"I mean them coming here. Alpha Centauri was our mission, and suddenly they send another ship, a ship that'll beat us home by years." Kroft studied a diagnostic readout. "There are so many other systems to explore. Why did they duplicate our assignment?"

The engineer shrugged. "To get the results faster."

"Well, doesn't that bother you?"

"I can't blame them. They have advanced technology. Why shouldn't they use it?" Kroft stared blankly at a screen. "Okay, Russell, it bothers me, but what can we do about it?"

"You tell me. You're the engineer."

Kroft didn't answer. Rearden quietly slipped back up the ladder and into the mess to reheat his dinner.

"Greetings, Captain Taliaferro, crew of *Armstrong*. I am Grigori Ilyich Kozlov, captain of the Euro-Russian Space Agency Ship *Tsiolkovsky*. Apologies for the delay, but our crewmember on duty did not think she should respond on her own authority. She informed me first thing out of hibernation."

Sound and video were fuzzy, thanks to distance and uncompensated Doppler effect. They were clear enough to show the lank, balding man, and convey his words in Russian-accented English.

"We received your messages, are still receiving them. Our planned insertion trajectory should not expose you to undue radiation. Please check the data we are sending on frequency 147 megahertz, and confirm.

"We would be glad to have any other information you can send us, so we do not start cold here, have to feel our way around. We can perhaps combine our efforts. How long are you still to remain in the system?

"Send us your latest information when you can. We will be busy, but not too busy to hear from you. Kozlov, *Tsiolkovsky*, signing off."

The four watched his image blink off the bridge display. Hu was the first to react. "Well, he didn't say very much."

Rearden was fuming. "Of all the arrogant—"

"Scott," Taliaferro broke in, "send them confirmation of our flight plan. There's no hazard of them frying us, but they should know."

"We should ask for some Earth history, too," Rearden said, "like why we so desperately needed a follow-up mission."

"And how they followed up so fast," Kroft added.

"First things first, gentlemen . . . but I wouldn't mind knowing, either."

Reasonable lag-time made Kroft's work easier. *Tsiolkovsky* readily confirmed that it had hydrogen-fusion drive, a breakthrough made seven years before launch and eagerly applied to a new generation of spaceship. The increased thrust allowed *Tsiolkovsky* to accelerate at one *g*, making things much more comfortable for the 'sleepwalking' officer.

Their crewmembers, three of each sex, each took a shift out of cryostasis for monitoring and maintenance. *Armstrong*'s original call had reached Winifred Mitscher. The planetologist, at twenty-eight, was almost too young to remember *Armstrong*'s launch.

The flow of data soon reached a bottleneck at Captain Kozlov. He insisted on having more information from *Armstrong*'s surveys, especially about Centauri A II, which they could already tell bore life. Captain Taliaferro was swamped with preliminary preparations for the boost home, and simply told Kroft to handle it.

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He handled it by taking Rearden's advice, and going around Kozlov's end. He figured out the duty shifts aboard *Tsiolkovsky* through study of the message logs and some guesswork, and convinced their engineer to keep their conversations "between professionals". He likewise kept their chats off *Armstrong*'s logs.

"I suspected it for a while," Hu said, "but I didn't want to believe Russell had you convinced. Why, Scott?"

"Because I'm right," Rearden answered for him. The three junior crewmen had the mess alcove to themselves, but still kept their voices at half strength. "There was an implicit understanding when we signed up for this mission. We give up fifty years of life on Earth, take the risks of cryostasis and isolation, and in return we get the glory for being the first humans to another star system."

"First, Russ, I don't concede your premise. Second, *Tsiolkovsky* doesn't change that. We still were first."

"But we won't return first," Rearden countered. "They'll make it back over fifteen years ahead of us. They'll make the big impact in the scientific community; they'll get the medals, the parades, the fame and fortune. We'll return to indifference, to family and friends dead or so aged they may not remember us. Everything we've done will go for naught. Alpha Centauri will be old news, and so will we."

"Decades of technology." Kroft was absorbed in a readout crammed with abstruse schematics, but he finally spared part of himself for the conversation. "Decades of advances gone past, and nobody particularly interested in whether we catch up. Perhaps we'll become fodder for historians, exhibits from the primitive mists of the Deuterium Age."

"What do you propose we do about that?" said Hu. "Ask *Tsiolkovsky* to give us a twenty year head start, or to go visit some other stars before heading home?"

"I asked about that," Kroft said. "Short surveys of both Centauris, then straight back."

"That settles it. We can't outrun *Tsiolkovsky* with deuterium engines. The end."

"Assuming we couldn't retrofit our engines," Kroft said.

"Well, that's impossible." Hu saw Kroft's face shift subtly. "Right?"

Kroft mulled over his answer. "I don't have all the specifications, but my theoretical discussions with Marashchenko are promising. Look." He showed the schematic on his screen, which Hu soon gave up trying to comprehend. "It's a plain matter of increasing pressure and temperature. We have abundant hydrogen as reactant. Converting it to fuel isn't tough."

"The equipment won't handle hydrogen fusion, Scott."

"*Armstrong*'s design team was very conservative. They had to be: it's a fifty-year mission. We don't tax the fusion chamber or the reactant nozzles to half their safety limits, and they'll work past those limits too."

Hu stared. "You can't be serious."

Rearden jumped back in. "Wipe off that horrified face, John. If Scott says something can work, it can work."

"Fine. Can it work?"

Kroft shrugged distractedly. "I'm working on it."

"That's pretty confident, from the—"

Rearden whisted him quiet, two seconds before Captain Taliaferro pulled himself inside. "Am I interrupting something, gentlemen?"

"No," said Kroft, poking at his lunch.

Rearden said nothing, but gave Hu a warning glare. "Nothing?" Taliaferro probed.

"Actually—" Hu nervously clasped his hands. "We were talking about getting home, sir. It's been a long mission."

"A considerable understatement, John, but don't get wrapped up in it. Any of you. We still have plenty of work before then. I have a course correction planned for—"

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Things slowly returned to normal in the mess, except that Hu angrily refused to meet Russell Rearden's eyes. His stomach had enough trouble, and not from freefall.

Two days from rendezvous, the main drive of *Armstrong* was visible as a bright dot, slowly resolving into detail. Immense photovoltaic arrays gathered power for the ship's batteries. A larger but invisible magnetic scoop harvested the solar wind for separators to comb into hydrogen reactant, deuterium fuel, and waste elements.

Automatic systems had the drive section in running order: so said Kroft's microwave link with the ship. He had its status reports running on half his boards, while he pored over engine diagrams and materials inventories on the other half.

To see these schematics, these designs of elegant power, at once enraptured and humbled him. They had gone so far; they could do so much. He sometimes despaired of duplicating their feats, before the light of intellect dispelled that shadowfall.

Conversion would be terribly hard: leaping the chasm of technological progress carved out by his quarter century of isolation; scaling the precipice of bending old implements to new purposes. But the knowledge was at his fingertips, the materials close at hand. No exigency—no metaphors, he joked to himself—would stymie him forever. He could do this.

"I know you're in there, Scott."

Kroft calmly switched his engine plans for status boards before Taliaferro pulled inside. He spent most of each day cooped up in here; it was no surprise the captain could divine his whereabouts.

"*Armstrong*'s systems all nominal," he reported upon seeing Taliaferro's head. "Batteries are charged; separators running well; the tanks will top off fine. Just wish we had kept more hydrogen." The separators had started dumping hydrogen three months before, when they had enough to get home. Restarting them two weeks ago amounted to drops in the bucket.

"We're better off without the excess mass." He pensively looked Kroft over. "You look like you're bracing to get hit. Whatever it is, spill it."

Kroft thought fast. He always had their scheme in mind, giving him a continuous anxiety with the undertow tug of worrying how to break the plan to Captain Taliaferro. He hastily substituted the first plausible trouble he could think of. "Do you plan on ordering me to upload all our discoveries to *Tsiolkovsky*, as Captain Kozlov, er, requested?"

Tsiolkovsky had swung into orbit around the lump of rock that was Centauri A's closest planet the previous day. Kozlov's messages now verged on belligerent, with talk of "unfraternal behavior" and "no secrets among scientists." Kroft bit his lip the instant the words were out. Douglass would do it, and they'd be that much worse off.

"I don't see why we should. Don't look so surprised, Scott. Why should he give our data a lift, if he can't do the same—" Taliaferro's eyes suddenly hardened. "Stupid. Never thought—we've done this the wrong way all along."

The captain clapped him on the shoulder. "Scott, call up *Tsiolkovsky*. Ask if they have extra cryochambers for a few deadheading astronauts. Ask if they have extra room and power conduits. We can dismantle our own pods, and reinstall them on their ship."

Kroft hesitated. It was the wrong time to call—but how could he explain how he knew that? "Will do," he finally replied, poorly feigning enthusiasm.

"Cancel that. Just make the connection. I'll ask them myself."

Kroft listened to Taliaferro's request, if anything too deferential in language and tone. "If they had planned ahead for us," he said after ending the broadcast, "they would have said so."

"Assuming they didn't expect to cross us in transit, where transfer would be impossible."

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"Maybe. We could get lucky," he said unenthusiastically, "get their engineer, maybe one of the dirtside scientists. Kozlov won't budge."

"Confidence, Scott. Besides, nothing lost either way."

Taliaferro stayed to count the seconds. Two hundred six out, an interval for the length of the message, two hundred six in, plus however long composing a reply took. It might be a while. . . .

Grigori Kozlov appeared, his pate a mottled red. "Captain Taliaferro—" He was now deliberately mispronouncing the name. "—This stratagem of yours is transparent. No, we have no spare chambers, or room for yours. Besides, our power consumption projections are calculated to the kilowatt, never mind the difficulties of conversion to your equipment. I cannot imagine how you would propose to get the chambers, or yourselves, aboard.

"If you will not share your data, then fine. We will collect our own, on schedule, by the book. Let us waste no more time over theoretical exercises. Good day, Captain."

Kroft felt a surge of anger he thought he had moved past. "'I cannot imagine—'" he mocked at the blank monitor. "No, you can't. You won't even examine the problem, you—"

"Easy, Scott. No loss, except maybe for him. I'll let you get back to work."

He departed, and Kroft did get back to work—his work.

Docking was smoother than glass, Captain Taliaferro not even needing the computer the last five klicks. They devoted the rest of that day to powering up the newly rejoined *Armstrong* and moving their most perishable samples into the bulk cryochamber. They worked well past ship's midnight, and none of them lost a moment falling asleep when the opportunity arose.

Kroft foggily roused himself after a scant four hours. He and the others planned this days before. He would begin rerouting reactant conduits to the laser chamber, and reconstruct the plasma containment fields to handle a hotter product. Rearden would be his shield, coming clean to Taliaferro the moment the captain became suspicious of his engineer's activities. He would explain their plan, with Hu's help if necessary, and convince him through logic, or if necessary through fait accompli. He'd need lots of time for that, though.

He took control of a work robot from the telepresence booth, and commenced disconnecting the deuterium feed conduit. He was ready to cannibalize the constriction field generator when the speaker clicked on. "Mister Kroft, could I see you in my quarters, immediately?"

His innards lurching sickeningly, Kroft left the booth in a blur. He found Taliaferro's door open, with the captain perched against the far wall, and the other two crewmen at his side. Hu particularly looked like a scared puppy.

"I didn't expect you to get busy so early. I thought you should come clean about your plans now, before you make too many changes I'll only have to set right."

He gulped. "W-what we intended, sir, Russell and John and—"

"Rearden and Hu weren't in the telepresence booth doing God knows what. You were. What were *you* doing?"

Kroft quailed before the mounting wrath of the captain. "I see I'll have to prime the pump," Taliaferro said. "I know the basics. *Tsiolkovsky* stuck in your craws, and you wanted a way to beat them home. Don't look so incredulous. I'm not blind. It was in your faces from the day we detected them. Not all of you at once, but eventually.

"I thought keeping you busy would snuff your resentment, or at worst that you'd recognize the patent impossibility of remedying the situation. Except for the deadheading idea, that is. That was no ruse, Scott. I really didn't think of it until the other day.

"Regardless, not only didn't you

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dismiss the notion, you built some harebrained intrigue around it. What is it?" He pulled himself toward Kroft by the ceiling grips. "Well?"

His resistance stripped away, Kroft began spouting. He told Taliaferro of his secret consultations with Marashchenko, his plans to retrofit the reactor and engines, his hopes of matching *Tsiolkovsky*'s speed with their fresh knowledge, properly applied.

"Have you thought any of this through?" Taliaferro demanded, his voice like a breaking thunderstorm. "Forgetting whether your new containment configurations could possibly hold for years, you'd drain the batteries long before then."

"I'll supplement them with surplus power from the reactor. I'll bypass the batteries; I know they weren't manufactured for constant recharging."

"What about hydrogen? Our stores won't last nearly long enough for constant one-gee acceleration and deceleration."

Kroft showed an instant of anger. "You opened my encrypted files."

"No, but let's say that Mister Marashchenko kept both his consultations confidential." He reached for a portable monitor, and pulled up a long scroll of equations. "Did you really think we were going to beat *Tsiolkovsky* with a burn that short?"

"No, but I have a way around that. I'm going to align the magscoop to collect interstellar hydrogen in flight, like the old Bussard designs."

"All right, how wide a field will give *Armstrong* enough hydrogen for full boost throughout the return leg?" Kroft's mouth worked around nothing. "I thought so. The answer is, you can't. You two, come over. May as well get the story straight with all of you."

He extracted a fresh set of figures. "That's how wide your magscoop field can be before increased drag and power consumption make anything larger counterproductive. That's your net hydrogen gain, compared to your requirements." Surprised faces surrounded him. "I used *Tsiolkovsky*'s best-case numbers, to be sure there wasn't a chance. There isn't."

Rearden and Hu didn't linger long on the numbers. "We trusted you," Hu hissed at Kroft. "You said this could work."

"It can," Kroft answered, clinging to the present tense. "I have a grip on the technology. The engine refit will work. Fuel's a secondary consideration; it can wait. I—I can use our deuterium as a reserve."

"After you've refit the laser chamber for hydrogen reactions?" said Rearden.

Kroft faltered. "Give me time. If I don't go into cryostasis immediately, work and adjust things while we're underway—"

"You can't," Taliaferro said. "*Armstrong* wasn't built for this. You can't change that fast enough to matter against *Tsiolkovsky*. We'll end up drifting, or screaming past Earth with no way to decelerate, or fatally irradiated, or any calamity in between."

He wheeled. "Then where will your place in history be, Mister Rearden? Lost in space! Not even first to Alpha Centauri, if Captain Kozlov and crew conveniently neglect to mention us. That's the hazard in your great gamble, gentlemen. Still care to roll the dice?"

Kroft looked at Hu, who wouldn't look back. Rearden glared sulphurously, then turned in scorn. Kroft tried to show Taliaferro a flash of defiance, but his countenance dissolved in mortification.

Taliaferro grunted weakly. "Rearden, initiate the solar array refolding sequence. Hu, start bringing the cryochambers back on line. Scott . . . Scott." Kroft arose partially from his remorse. "I'll go with you to help reverse your modifications. Dismissed."

The junior officers disappeared from Taliaferro's presence with all speed, but Kroft had to be led along. "Captain . . . Doug . . . I'm so . . ." Taliaferro interjected nothing into Kroft's misery, except for their necessary work. . . .

* * *

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Taliaferro observed his crewmates, out of their chambers, all looking and feeling lousy. One by one they turned his way. "First the bad news. *Tsiolkovsky* wasn't the first ship to return from Alpha Centauri."

"Wh—" In his surprise, Rearden slipped from his perch, and drifted to the deck in one-tenth *g* freefall.

"What happened?" Hu mumbled through a cottony mouth. "Explosion? Collision?"

Kroft shook his head. "With our luck, another ship came and beat us both."

"Would you believe two ships?"

Kroft goggled. Rearden disgustedly thunked his head against the deck, and lay there. Hu nodded, almost smiling. "Yeah, I think we can believe that."

"I worked out a rough timetable from the course corrections the computer made. Fortunately, Houston's data are far more thorough."

All eyes turned to the recording rod he produced in his hand. "This is the good news, and I think you'll want to hear it all."

They all gathered at a viewer to watch Houston's broadcast, and receive a short, copious lesson in the history of the Second Space Race.

Hydrogen fusion brought the launch of *Tsiolkovsky*, at a time when graviton generators were clearly on the horizon. With that breakthrough came the avalanche. Ships could boost at far above one *g* with no ill effects on crew or superstructure. First *Yamato Uchusen*, then *Aldrin* set off to lap *Tsiolkovsky*—*Yamato* barely winning the race back.

New missions darted to other nearby stars, one straggling back from Sirius the previous year, two others long overdue. Many had been first to a particular system, or briefly held speed or acceleration records. None of them held what *Armstrong* did: cargo bays and computer banks filled with knowledge.

As far back as *Tsiolkovsky*, the nature of the Race made tarrying to collect pictures, measurements, and samples counterproductive. Earth knew of the living world orbiting Centauri A, but precious little of its geology, meteorology, biology, or compatibility with Terran life forms—until *Armstrong* returned.

"We couldn't send other ships," their contact said in her welcome Texas accent. "The Race drained the economies of every spacefaring country. The United Nations is still in debt to two dozen banks for their Barnard's Star mission. Public hostility has barely receded enough for us to begin building another Centauri explorer.

"With these preliminary results you've given us, though, mission scientists are already jamming computer lines to get at your data. They're talking about shifting the mission to permanent research, even civilian colonies. But don't worry. You'll have a couple years of rest before anybody starts begging you to join the new crew.

"We'll want reports from the junior officers, including evaluations of the captain. He's already sent his, and they're everything we expected of you. Good work.

"That's all from us. See you in seven days. Out."

Eight eyes lingered on the darkened screen for a second, until Rearden whooped loudly enough to shiver the bulkheads. "Yeehah! We won after all!"

Kroft and Hu nearly joined in his revelry, before the looming, silent presence of Captain Taliaferro doused their ardor. "Gentlemen, if you can wait a week to celebrate, I will gladly join you. For now, we still have duties."

Rearden and Hu headed off quickly, while Kroft stayed a moment. "Thank you, Doug. Thanks for all you did—and something you didn't do."

"Don't mention it. I wanted to give this crew a break. Who knew they had a bigger one coming? Off with you, Scott."

"Sir." Kroft left Douglass Taliaferro alone. After a moment of rigid solemnity, a gleaming smile cracked the face of the first captain to Alpha Centauri.

Then he got to work.■

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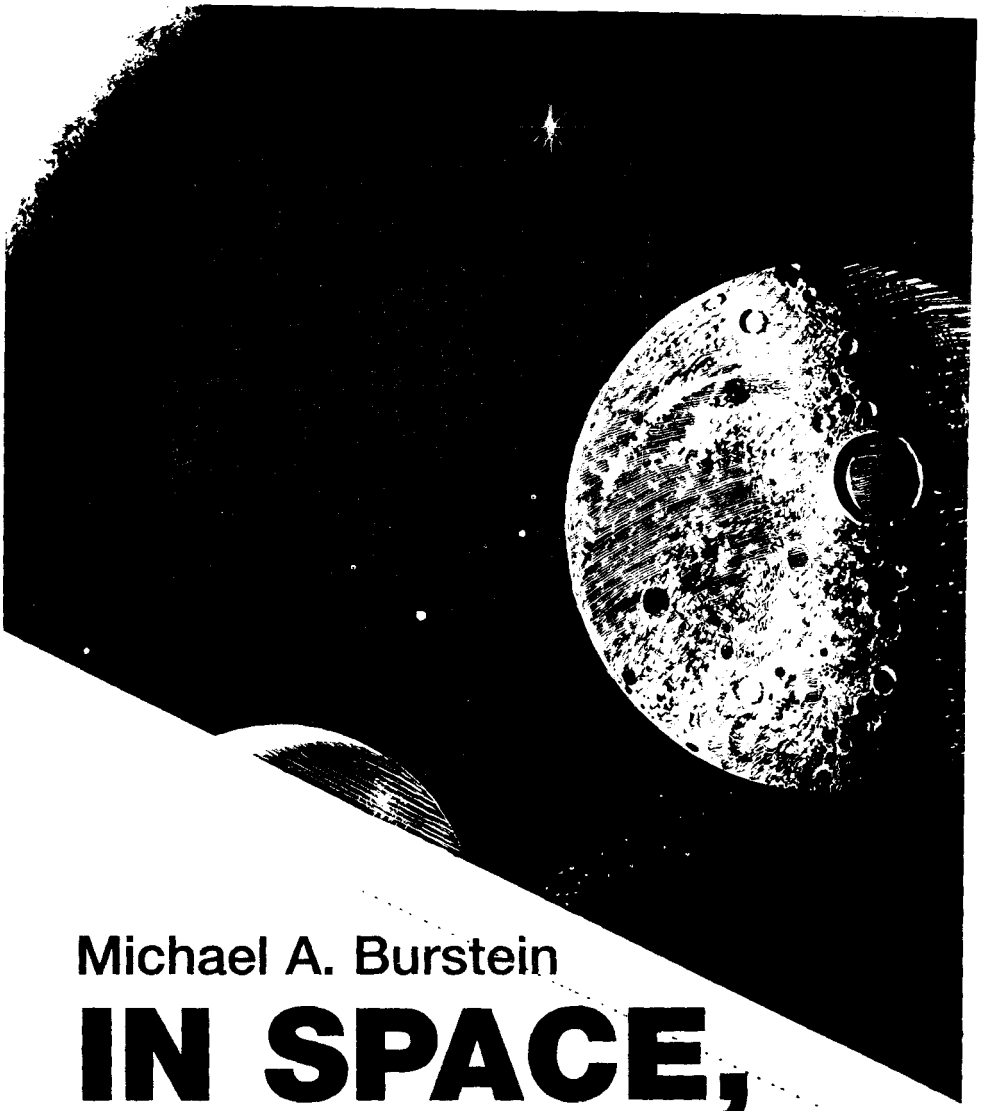

Michael A. Burstein

IN SPACE, NO ONE CAN HEAR

"Advantages" and "disadvantages" are inherently relative terms. . . .

Illustration by Vincent Di Fate

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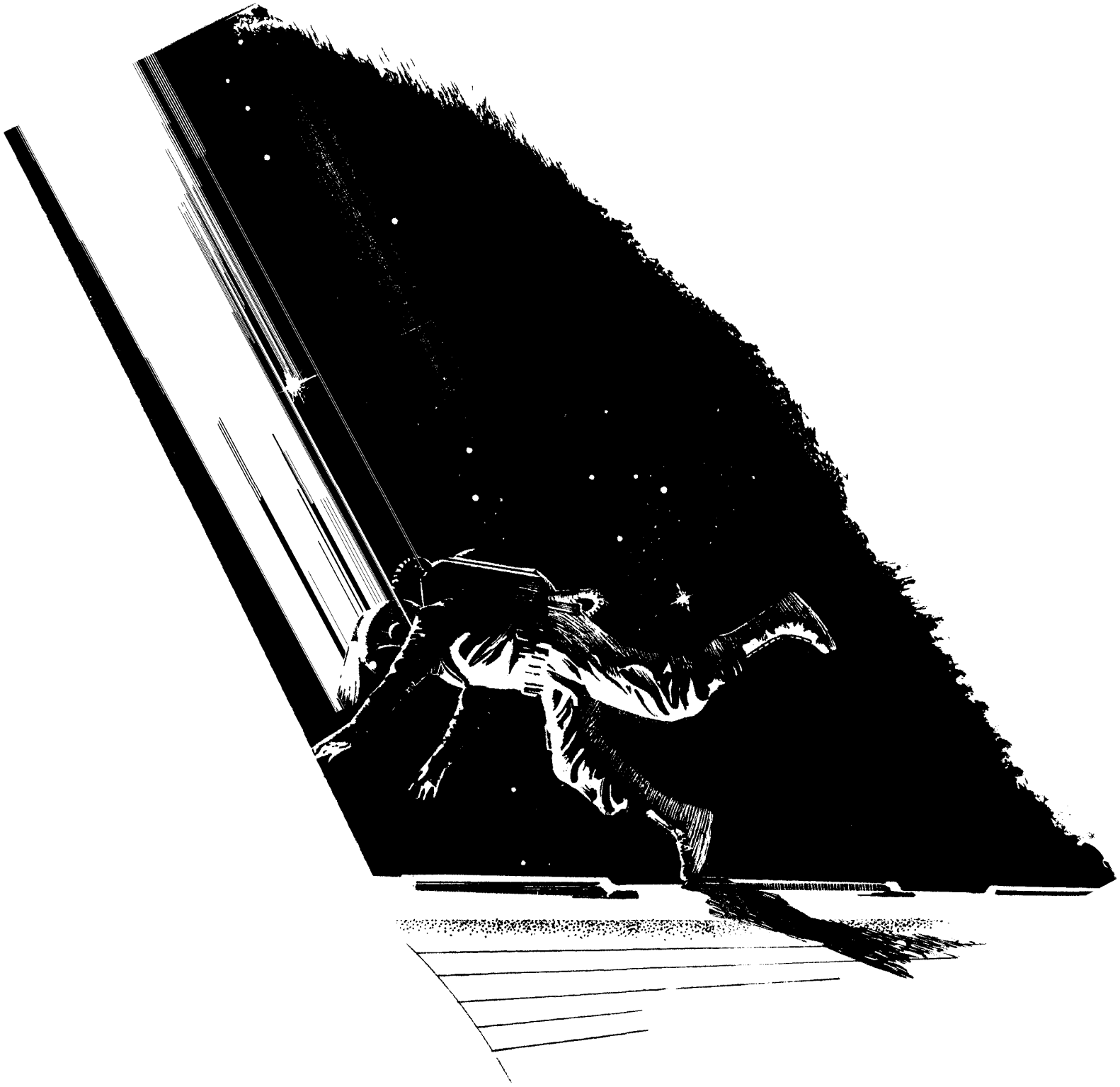

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The silence was deafening, which was ironic in its own way.

Jacob Galiano tapped the side of his helmet again in an attempt to get the radio to work. Nothing. He sighed and continued crawling along the outside of the *Urshanabi*. The metal foil of his emergency EVA suit crinkled as he flexed his muscles. He made sure to face only the surface of the cylindrical spaceship; its continual rotation brought him within sight of the Sun every minute or so, and despite the protection of the visor, he didn't want to risk directly exposing his eyes.

Jake grabbed another handhold and pulled himself across. His senses confused him. He liked to think of the Earth as being down and the Moon as being up, but that didn't work in free fall, especially when clinging to a rotating spaceship that pointed towards neither.

Another handhold, another foothold, and Jake pulled his slender frame another few meters towards the passenger cabin. He cursed silently to himself. He was a shuttle pilot, not a repair technician. If security had been better, and the computer still functioned, he wouldn't have to be out here, risking his neck to save everyone's life.

Including that of his brother, Ron.

It had all started back on Terra One, the civilian commercial space station and vacation spot run by People Movers, Ltd., in low Earth orbit. People with enough money would pay to visit the rotating station for a week or so, enjoying the low gravity and the view. People with more money, and the inclination to do so, would stop at Terra One briefly and then continue on their way to a moonside vacation.

Jake piloted the *Urshanabi*, one of the five passenger shuttles that routinely traveled between Terra One and Luna One. Standard procedure was for the flight crew to board the ship an hour before any passengers arrived. This time around, however, Jake had arranged to meet his brother Ron ten minutes before the rest of the flight crew was supposed to arrive. When he got to the docking bay, Ron was waiting there for him, a bag presumably stuffed to the limit of his mass allowance at his feet.

Jake hadn't seen Ron in a few years, and he took a moment to take in the sight of his brother. Ron's hair was still dark black, as opposed to Jake's gray-black hair, and his mustache was thick above his lip. Ron still wore glasses; he wasn't the sort of person to get his vision corrected. Jake had been required to get his nearsightedness eliminated, to qualify as a shuttle pilot.

Ron didn't notice Jake's approach until Jake was in his line of sight. As soon as they spotted each other, though, they smiled and hugged.

Once they disentangled, they began to converse in Sign.

"*It's really good to see you. How are you?*" Jake asked. "*It's been so long—too long.*"

"*Not that long—just years and years. You never write, you never call . . .*" Ron smiled at his joke chiding his brother; actually, they communicated quite frequently by electronic mail.

"*It's only been three years, Ron.*" Jake laughed and tousled his brother's hair.

"*So what's up? I see piloting spaceships agrees with you.*"

Jake felt sudden embarrassment for two reasons. First of all, he wanted to fly *real* spaceships, such as the explorer ships headed to the edges of the solar system. But he had failed to pass the test required by People Movers' parent corporation, System Explorations, for frontier pilots. Instead, he was stuck ferrying people in the Earth-Moon system.

And second . . . the second reason he didn't want to think about. It was too much like pitying Ron. Instead, he took the path of modesty. "*I don't really do much. Launching, docking, minor course corrections, that's all.*"

"*Still, you do pilot spaceships. It must be exciting.*"

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Jake shrugged. "*The only excitement happens when another one of those anti-space groups decides to come up here for a demonstration. And I'm not flying spaceships, really. Just a shuttle. Have you seen it yet?*"

Ron shook his head. "*Only in pictures.*"

"*Here, take a look.*" Jake guided his brother over to one of the portholes, which gave a slightly askew view of the *Urshanabi*. Ron studied it for a few seconds, then turned back to Jake.

"*Interesting ship,*" he said. "*It's not like the one that brought me up here. That one had much larger rockets, but inside it was cramped.*"

Jake nodded. "*We don't need solid rocket boosters just to get from low Earth orbit to Moon orbit. We use—*"

Ron interrupted him. "*I know that!*" The quick movements of his hands showed his impatience.

Jake felt his face flush. "*Sorry.*"

"*Simple chemical thrusters, right? Oxidant mixed with propellant?*"

Jake nodded. "*The cabin's larger too. Overall, though, it's about the same size as the shuttle that took you up here—if you include the boosters.*"

The two continued chatting for a few more minutes, until the rest of the flight crew showed up. Ron was the first to notice them; he felt the vibration of their steps on the metal floor of the dock. Jake was only expecting three people, and he was slightly surprised to see a fourth person with them.

"*Come on, I'll introduce you.*"

Ron held him back. "*Could you let me know who they are, first?*"

"Huh?" Jake asked aloud. Then he remembered. Being Deaf, Ron preferred to know people's names before being introduced. It saved time later on. "*Oh, sure. The short Indian woman on the left, in the blue jumpsuit like mine, that's Shamita Rao.*" As usual, Jake fingerspelled the name, then assigned a shorthand name-sign to her so he and Ron could refer to her more quickly later on. He made a fist with the thumb across the fingers, the handshape for "S," and lifted it up to imitate the sign for "rocket." "*She's the other pilot. The tall blonde woman in the white jacket is Sally Gershon. She's one of the flight attendants. And the man with black curly hair in the matching white jacket is Yuri Smirnov. He's the other.*"

"*Russian?*"

Jake laughed. "*His family is, but he grew up in Boston, just like we did. Shamita's from Calcutta, though, and Sally's from London. As for the blond man in the white overalls and red cap . . .*"

"*Yes?*"

"*That's Matt Marino. He's one of the computer techs on board the station.*"

"*What's he doing here?*"

Jake shrugged. "*Remember the protestors I mentioned before?*"

"*Yes.*"

"*Well, every so often, the Earth Firsters or some other group manage to rig the entertainment computer to spout their nonsense. With lots of new vids constantly coming in from Earthside, it's easy to infect the disks. And company regulations say that all the ship's computer systems have to be checked by one of the techs for viruses and flushed. Annoying nuisance, if you ask me; it sometimes delays departure. But hey, that's regulations for you. Except . . .*"

"*Yes?*"

"*Well, we haven't had that problem in a while. I wonder why Matt's here.*"

A few seconds later, the four others had approached within conversation distance. They greeted Jake, who responded in kind, while Ron just stood there.

Finally, Jake said, "Guys, meet my older brother Ron."

Sally and Yuri said hello, shook hands with Ron in turn, then approached the airlock. "We've got a bit more to do than usual today," Sally said.

Matt nodded. "Damn straight. Those stupid protestors again." His eyes wandered around the dock. "Looks like they

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managed to clean up from last time, though. You guys missed a major demonstration when you were back on Luna One. When they were done, there was garbage everywhere."

"Matt," Jake asked, "why are you here? Our entertainment system's been running fine."

"New regs," Matt replied. "Management's gotten antsy. They want the computer systems flushed before every launch now."

"Of course," Jake said, rolling his eyes. "Well, you'd better get to work then. Don't want to delay takeoff."

The flight attendants cycled the airlock, causing Jake, Shamita, and Matt to cover their ears with their hands; the rush of air and the clanking of the electro-mechanical locks were a little noisy. Of course, the noise didn't bother Ron. Once the airlock was open, Sally, Yuri, and Matt passed through it in turn.

Shamita paused at the airlock, then turned to Ron, shook his hand and said, "Pleased to meet you."

Ron turned to his brother and signed, "*Nice to meet you, too.*"

Jake nodded at his brother. Aloud, he said, "Ron says it's nice to meet you too."

Shamita looked bemused. "What was that?" she asked Jake. "Why'd your brother wave his hands around like that?"

Jake smiled weakly. "Sorry, I haven't told you yet. Ron's Deaf."

Shamita turned to Jake. "Deaf? You mean he can't hear?"

"That's right."

"But—can't they fix that?"

Jake sighed. "It's a long story. But there are many Deaf people all over the world, and they communicate with Sign language."

"Oh." Shamita looked thoughtful for a moment, then asked, "Can your brother talk?"

Jake shifted; he felt uncomfortable, talking in front of his brother. "Yes, but—why don't you ask him? I'll serve as interpreter. Just make sure to look him in the eye when you talk; don't look at me."

Shamita looked a little uncomfortable, but nodded. "Oh, OK." She turned to Ron. "Jake tells me that you can talk. Is that true?"

Ron looked at Jake and signed: YES TALK I CAN, CHOOSE NOT. HEARING UNDERSTAND ME NOT. In the traditional role of the interpreter, Jake spoke exactly what Ron signed. "Yes, I can talk, but I choose not to. Hearing people tend not to understand me too well anyway."

Jake saw Shamita turn to look at him, but he shifted his eyes back towards Ron as a cue for Shamita to keep facing Ron. She got the hint. "Oh. I'm sorry," she said to Ron.

Ron shrugged and signed: DEAF PERSON YOU MEET NEVER BEFORE. "Don't be," Jake interpreted. "You've probably never met a Deaf person before."

She nodded. "That's true." She paused, then said, "Jake doesn't usually talk about his family much."

Jake dutifully interpreted her words correctly, but felt himself flush as he interpreted Ron's next words. "Jake talks about work to me all the time. He tells me you're one of the best pilots in People Movers."

She smiled. "Thanks for saying that, both of you."

Jake interpreted her words, nodded, and then said to both of them with voice and Sign that it was time to get inside. Wordlessly, the three of them entered the *Ursbanabi*.

An hour later, the fifty or so passengers having boarded the shuttle and Matt Marino having left the ship, the airlock closed and the *Ursbanabi* was ready to leave. Jake never tired of launch, no matter how standard the routine had become. Once the passengers and flight crew were strapped in, Jake and Shamita took the *Ursbanabi* away from the station and burned the thrusters until they were floating in stan-

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dard launch orbit. Jake enjoyed the sensation of free fall, but imagined Sally and Yuri didn't, dealing with the temporary disorientation of the passengers. He didn't envy them their job. At least the ship was only filled to about half its capacity.

"Well, that's it," Jake said once they were on their way. Regulations required both Shamita and him to be alert for another hour, although he knew nothing ever happened. Even this close to Earth, space was relatively empty. "Do you want the first sleep shift?"

"Sure, I'll take it."

"Chess first?" Jake smiled; they usually used the computer to play chess against each other at least twice per flight, and so far, he was ahead in wins.

"I'd rather just chat, actually."

"About what?"

"Your brother. You never mentioned him before."

Jake paused. "Oh. OK. Well, I suppose I had to talk about it sometime."

"Huh? Talk about what?"

Jake took a moment to check the controls, even though he knew the ship was on course. "I got my interest in space from Ron."

"Really? You never mentioned that."

Jake nodded. "It's something I've always felt bad about. Ron was always the one who was into space travel. And its early history. Mercury, Gemini, Apollo, Soyuz, Artemis—you name it, he devoured everything he could find about it. He always wanted to travel into space, fly to the Moon, see the outer solar system."

"So why didn't he—oh."

"Exactly. They don't hire deaf astronauts."

"Too bad," Shamita said. "So what does he do?"

"Well, he wanted to be an astronomer, but he didn't like math. So he does amateur astronomy on the side, but for a living he's a teacher of English literature. He also teaches Sign."

"How can he teach if he's deaf?"

Jake forgave Shamita in his mind for asking the question; there was no reason for her to have known. "Quite easily. He's the Stokoe Professor of English Literature at the Rochester Institute of Technology in North America."

That got Shamita's respect. "Really? A professor?"

"Uh-huh. In fact, it was Ron who told me that Urshanabi was the ferryman for Gilgamesh when I first got this assignment. He really knows his stuff. There's an international institute for the Deaf on the Rochester campus, so all his students also know Sign. And he teaches hearing people Sign, in the same way you can teach any foreign language to people who don't know it. He can communicate through speech, lip-reading, and electronic interpreters."

"Electronic interpreters? You mean like language translators?"

Jake nodded. "Only it doesn't translate what someone else says into another language. It just prints the text of what someone says onto a screen."

"The translators never seem to work too well," Shamita observed.

"Same for the interpreters. They tend to get a lot of words wrong. Besides, it also inhibits conversation because the hearing person has to speak into the microphone and then hand the interpreter over to the Deaf person to read. Have you ever tried to carry on a conversation using one of the electronic translators?"

Shamita nodded. "It's awkward."

"Then you can understand why Ron doesn't like them. Besides, they're somewhat expensive."

"Hm. How did your brother afford the trip to the Moon?"

Jake was slightly surprised at the question, but answered it. "He really wanted to go, so he saved up." And, although he didn't say it aloud, Jake had helped him out a bit. Spaceship pilots earned a lot more than teachers.

"Oh. OK. Um, Jake?"

"Yeah?"

"Can I ask you a personal question?"

Jake hesitated; she was doing it again.

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Didn't she realize that she was already asking a bunch of personal questions? He liked Shamita a lot, but she had a tendency to probe obliviously into private subjects. It often got on his nerves. Still, they had to do something during this dead time. "Sure."

"It seems to me that deafness ought to be, well, curable."

Jake winced. "First of all, don't use that word. A lot of Deaf people don't think of their condition as one that needs to be cured, or fixed. And secondly, while it is possible to—to correct congenital deafness, Ron is what's called 'post-lingual deaf.' He could hear until age three or so, but a bout of meningitis cost him his hearing."

"Ah. So gene therapy would do him no good."

"Right. Although . . ." Jake thought for a moment about two Deaf friends of his, who had congenital deafness in their family line but chose not to get gene therapy for their children. They hadn't wanted to raise hearing children, because they felt that, as the children grew up, they would become isolated from them. It was an ironic reversal of the usual case of hearing parents who find themselves raising a deaf child, unable to cope.

Shamita wouldn't understand. "Never mind," Jake said.

"OK." Then, as if she realized she had probed too deeply into his personal life, she changed the subject. "Tell me more about Sign language. It looks interesting."

Jake felt relieved at the change of subject. He found it easier to talk about something objective than to talk about his brother. "It is interesting, or at least I've always thought so. Most hearing people don't know Sign, but I picked it up being Ron's brother. It was established to be a real language in the twentieth century, although its roots go further back."

"You must not get to use it often."

Jake shrugged. "Well, not here in space, but at home I've used it quite a lot. I'm considered a member of the Deaf community—that's with a capital 'D' in Deaf. That's partly because I'm Ron's brother, but also because I can sign fluently."

"Can you show me how it works?"

"Certainly. Let's see." He thought for a moment. "OK. Watch closely."

First Jake wiped his left palm with his right palm, in a sweeping outward motion. Next he shaped his hands into two fists with his index fingers extended, and brought the fists together. Finally, he pointed directly at Shamita.

"These three signs mean 'NICE,' 'MEET,' and 'YOU.'" If you wrote it down in what's called ISL gloss, you would just write down those three words. But when signed, it's a proper sentence, the equivalent of saying 'Nice to meet you' in English."

Shamita looked confused. "ISL gloss?"

"Sorry. ISL is International Sign Language, developed in the twenty-first century when the international Deaf community decided to create one overall language that would transcend borders. It's based around American Sign Language, which in turn evolved from French Sign Language. Not all Sign languages were the same, although hearing people didn't often realize that."

"And gloss?"

"Gloss is—well, it's sort of a way of writing each sign as one English word. It's a bit technical."

Shamita laughed. "You're sounding like a linguist, not a pilot."

Jake shrugged. "One of my hobbies. Grow up with a Deaf brother, and you become more conscious of sound—and the absence of sound. I actually grew up fluent in both English and Sign, so I know a lot about language."

Shamita bit her lower lip for a moment. "I have trouble thinking of that as a language. After all, it just seems like gesturing. You know, like pointing at me to indicate 'you.' That's somewhat simplistic."

Jake tried to keep the offense out of

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his voice, but didn't succeed. "Well, it's a lot more involved than that."

"Oh, obviously. It just seems weird, that's all."

Jake grunted. "Let's play chess now."

To his relief, Shamita assented.

Shamita won two games out of three. She took her sleep shift, then woke in time for both of them to be ready at the halfway mark, twelve hours in, when it was time to turn the ship. Jake was yawning as Shamita strapped herself into her seat.

"Ready?" Jake asked her.

"Yes."

"OK, let's do it." Jake hit a button to communicate with the passenger cabin. "Ladies and gentlemen, this is Jacob Galiano, one of your pilots, speaking. We're about to turn the ship around to aim us right at Luna One. Until we dock, this will be the only time that we'll be out of free fall, as the rotation of the ship will feel like gravity pushing you down against your seat. Following the rotation, you'll feel another push in a different direction as we fire the rockets. Please stay in your seats, secure your belongings, and make sure you are strapped in until we say otherwise."

Jake released the button and pushed another one, to communicate directly with Sally and Yuri via their radio headphones. "Sally, Yuri, are we set?"

"One moment, Jake," came Yuri's reply.

Jake sighed and waited for a minute until Sally's voice came over the radio. "Sorry, Jake. Everyone's strapped in now. One of the passengers was having trouble with the free fall toilet. You know how it is."

"Yeah, I do. Listen, make sure my brother's strapped in as well."

"Hold on, he's right above me. Yes, he's strapped in."

"Good. Cockpit out." Jake released the button, and turned to Shamita. "Your turn, or mine?"

"Yours, I believe. Go to it. I'll fire the rockets."

Jake nodded and poised his finger above the gyro button. "Hold on." He pushed the button. The ship slowly began rotating, and a timer just above the button turned on, counting down from thirty-two seconds. Jake felt himself being pressed into his seat as the centripetal force did a good imitation of gravity. As soon as the timer hit zero, Jake released his finger from the button, expecting the feel of the induced gravity to decrease slowly back to nothing over the next thirty-two seconds.

But half a minute later Jake continued to feel the same constant push of his weight onto his seat. Confused, Jake looked out the window at the starfield, which was definitely continuing to rotate at the same constant rate.

"Jake? What's happening?"

He started to feel a slight panic. "I don't know. We must still be rotating. Check the status of the gyro on the computer, will you? Maybe something's stuck, and we can jiggle it loose."

Shamita pushed a button, and a status screen appeared on the monitor in front of them. "It reads—" she started to say, and then the computer beeped loudly and the monitor blanked out.

"What the—Jake, the computer's out!"

Jake stabbed at a few other buttons. Despite the controlled humidity of the cockpit, he felt himself beginning to sweat. "Not possible. Only thing that could do that is a solar flare, and the forecast was clear." It *had* to be clear, or launching *Urshanabi* would be a death sentence for all aboard.

"Wait a minute—something's coming back up." Shamita paused, then said, "What in the world . . . ?"

Text began to scroll down the screen, in many languages. Jake tracked the English. "Greetings to the pilots of People Movers. For too long has money been spent by the rich on pleasure jaunts in space, rather than to help the poor on Earth. Your corporation has consistently refused to acknowledge us and meet our

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demands, and so we have decided, finally, to take action.

"By activating your gyro, you have triggered a computer virus which has completely disabled your ship. Your complement of rich passengers will float forever in the limbo between worlds, a lesson to those who might choose to neglect Mother Earth and her inhabitants in favor of wasting their money on the siren song of outer space.

"And as for you, claiming your innocence in the crimes of your corporation, remember this. If you're not part of the solution, you're part of the problem.

"EARTH FIRST. EARTH ONLY. EARTH FOREVER."

Jake finished reading the text before Shamita. "How the hell did they do this?" he asked aloud, and then realization struck. "Marino! Why, that no good bastard. He must've infected the computers when he claimed to be flushing them." He thought a moment. "I should have been more on my toes this morning. If management had actually ordered a complete flushing of the computers before every trip, we would have been told." He shook his head. "I can't believe he'd throw himself in with those anti-space nuts."

Shamita finished reading the statement and turned to Jake, an uneasy look in her eyes. "You know, Jake, they do have a point."

Astonishment hit him. "Don't tell me you sympathize with them!"

Shamita glared at him. "If I did, would I be here? But, Jake . . ." Her eyes got a faraway look for a moment, and Jake could tell that there was more to it than the resentment she felt in piloting people who were much richer than she was. "My grandmother used to tell me how, when working in the fields, her friends and she would sometimes see jet planes flying overhead. All activity would stop until the trail of smoke faded away. She told me that every time she saw a jet, she would think of the money spent on it that could have gone to feeding the hungry."

Jake shook his head. "But space exploration benefits everyone in the long term! Colonization relieves population pressure, new technologies make it easier to feed people—"

"Jake, you're ranting. Both you and I know what the benefits of space exploration are." She pointed at the text still on the screen. "But it's them we have to convince, not us, and so far, we haven't done a great job of it."

Jake nodded slowly. "Speaking of jobs, we've got another job to do now, and that's to save our skins. You're the computer expert; see what you can do, OK?"

Shamita began hitting various buttons on her panel. Jake studied the controls in front of him, trying to think of something he could do.

After a minute, Shamita leaned back. "Hm."

Jake turned to her. "What is it?"

"Well, I've confirmed it. It's a computer virus set to activate when we turned on the gyro, just like they said."

"How bad is it?"

"Whoever wrote it is damn good. Our computer system is completely disabled. We can't do anything that requires the computer, and that includes shutting off the gyro, or firing the rockets. Thank God they didn't disable life support." She looked up, frowning. "Of course, that is a mixed blessing. They wanted us spinning out of control, but alive to suffer."

"So our deaths would be slow and painful. Can you fix the problem?"

Shamita rolled her eyes. "What do you think I've been trying to do?" she asked, and returned her attention to the computer.

A minute later, the computer beeped at her and she cursed.

"No go?" Jake asked.

She shook her head. "The system's just not designed for this kind of access."

"Can't you reboot the computer?"

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"How? Turning off the computer means shutting down the life support systems."

Jake nodded. "Continue trying to deactivate the virus. I'll have Sally or Yuri turn off the gyro manually. At least then we can try to reorient ourselves." He pushed the radio button.

Silence.

"That's odd." He tried again, and still got nothing.

"Um, Jake?" Shamita said. "That's not going to do any good. The radio's digital tuning is designed to scramble the signal through the computer, remember? No direct link, so our internal communications can't be monitored." She grimaced. "It's a security feature."

Jake sighed. "Well, right now it's a bug. I doubt we can even radio for help. I'll go take care of the gyro myself." He unstrapped, stood up, stepped carefully over to the door, and pushed the button to open it.

It didn't budge.

"What the—" He pushed the button again, still to no avail.

"Oh, damn," Shamita said softly.

Jake's head snapped around. "What? What is it?"

"Jake, Matt had access to *all* the computers. Including—"

"Including the ones that control the doors." Jake nodded grimly. "Damn! Now what do we do?"

"Won't Yuri and Sally realize something wrong?"

"Even if they do, they're not about to try to fix it without knowing what the problem is. They'd be afraid of making things worse."

There was silence for a moment, which Shamita broke. "So we're stuck here until someone realizes that *Urshanabi* hasn't come in. Call it a day or so until we get rescued."

Jake shook his head. "Even when they realize we're missing, they still have to find a ship to search for us, and by then we'll be so far off the regular flight path . . ." He trailed off.

"We can't accept that, Jake. There's got to be a way to stop us from spinning."

"The only way to do that would be to tell Sally and Yuri to go into the gyro compartment and turn it off."

"But how? With no radio, there's no way they can hear us."

Jake thought for a moment. "They can't hear us. . . ." he murmured.

"What?"

"You're wrong. There is a way to get through to them, but it means I'll have to go outside. Will the emergency front airlock work?"

Shamita nodded. "It's a manual lock. But Jake, you won't be able to get inside the cabin. How can you communicate with Sally and Yuri?"

Jake opened up the locker with the suits inside. "Through Ron."

And now, here Jake was, doing his best imitation of a human fly. He had just reached the edge of the cabin exterior; next, he had to find his brother.

Which was not going to be easy. The seats inside the *Urshanabi* went all along the "floor" of the inner cylinder, so all the windows appeared to face "down" as far as the passengers were concerned. Most of them would enjoy the view for the first few minutes of the trip, but then would stop looking down in preference to reading, sleeping, or watching the in-flight movies. Other more vertiginous passengers would ignore the windows altogether, and keep their eyes facing in any other direction.

Fortunately for Jake, vertigo was not a trait that ran in his family. It took the better part of an hour, but he finally found his starstruck brother. Ron was facing down, gazing into infinity, with a lazy smile on his face.

Jake pulled himself up close to the tinted window, so Ron could clearly see him. Ron's expression suddenly changed from contented to startled. Frowning, he signed histrionically, "*Jake? What are you doing out there?*"

Jake braced his feet against the hand-

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holds. "*Ron, don't draw attention to yourself. How are the passengers?*" It felt oddly constricted, signing in a spacesuit. He had to make his signs more expressive, slower.

"*Huh? They're fine.*"

"*They don't know about the problem?*"

"*Problem? What problem? You mean with the entertainment system?*"

Jake felt confused. "What problem with the entertainment system?"

"*The movie stopped, and some weird guy came on. I don't know what he said, because the captioning went out. But people got upset, so they turned it off.*"

Jake nodded. Infecting the movie computer was traditional for the Earth Firsters; he just didn't expect them to still do it when they had already done something worse. "*Sorry. Ron, we need your help. A computer virus has disabled the ship—*"

"*What do you expect me to do about this?*"

"*Ron, calm down! Just pay attention. Do you feel the pull of gravity towards the floor?*"

"*Yes. Isn't that normal? You said that we turn in the middle of the trip, and your friends were saying something to the passengers an hour ago.*"

Jake nodded. "*It's normal, but not for this long. Here's the problem. The gyro—*" Jake fingerspelled the word, as he didn't know the sign for it—"*the thing that's spinning the ship, is a round metal ring in a compartment which surrounds the passenger cabin, directly at the center. It was supposed to stop spinning, but it's still going. I can't access it from out here, but there's an entrance panel inside there with you.*"

"*But I don't know how it works!*"

"*No, I know that, but Sally and Yuri do. I want you to get one of them over here.*"

"*Wait here,*" Ron signed, and then smiled and shook his head. "*I can't believe I told you that. I mean, where can you go?*"

Ha ha, Jake thought, and waited for Ron to return.

A few minutes later, Ron returned to the window, with Sally looking over his shoulder. She looked vaguely distressed. Jake gave Ron a puzzled look.

"*She wants to know what's going on.*"

"*First, ask her how the passengers are doing.*"

Ron nodded and spoke aloud to Sally. It was impossible to hear them through the window. Looking towards the window, Sally started to say something to Ron, but Ron stopped her and said something else. Sally finished her sentence, looking directly at Ron, and then Ron turned back to the window.

"*Sorry. I had to explain to her that I couldn't read her lips if she didn't face me.*"

Jake nodded and smiled. "*So what's up?*"

"*She says that the passengers don't realize anything's seriously wrong, although some of them are starting to wonder what's going on over here. But she and Yuri kept trying to reach you on the radio, and couldn't. She says the spinning should have stopped by now.*"

"*She's right. OK, here's the story.*"

Through signing to Ron, Jake was able to explain to Sally about the computer virus and the problem with the gyro. "*Tell Sally that she or Yuri is going to have to open the hatch to the gyro compartment. Then they can go inside and activate the mechanical clamps. Once the ship has stopped spinning, we can figure out the rest.*"

Ron conveyed the rest of the message to Sally. She nodded, gave Jake a thumbs-up, and then disappeared from his view.

"*Are you going in now?*" Ron asked.

"*I want to wait until I know everything's under control,*" Jake replied.

A minute later, Sally returned, and

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went through the same rigamarole with Ron as before.

"*She says that the clamps aren't functioning,*" Ron signed. "*She pushes the buttons and nothing happens.*"

Jake wanted to rub his eyes in frustration, but obviously couldn't. The virus was too thorough. "*Tell her she'll have to crawl along the compartment ring, closing each clamp manually.*"

Ron passed on the message, and after a moment had Sally's reply.

"*She says that she can't do that.*"

"*Why not?*"

Ron smiled. "*Get this. Apparently, the screeching of the clamps on the gyro is beyond the pain threshold for human hearing.*"

Jake paused. "*Ron, can you—*"

Ron interrupted him. "*Yeah, Jake, I've already figured it out.*"

Jake nodded. "*Have Sally explain to you exactly what needs to be done. Remind her to time it correctly, so we're pointing in the right direction.*"

"*OK. Are you going back in?*"

He shook his head. "*I'll wait until the ship is back on course,*" Jake replied. "*Then I'll go back to the cockpit. Stabilization is only part of the story. We still need to get the rockets to fire.*"

"*You said the computer was out.*"

"*Yes, so—*" Jake stopped signing, and stared out at the stars for a moment. "*You're right. Firing the rockets requires the computer. Unless . . . Ron, when the ship stops rotating, I'll need you to talk to Sally again. She and Yuri will have to fire the rockets manually.*"

Ron nodded. "*Good thing I was along, then, isn't it?*"

Jake made a fist with his thumb over his fingers, and bent it back and forth at the wrist, like a nod. The sign for YES. "*Yes. Yes, it is.*"

The *Urshanabi* arrived at Luna One only a few hours late. The docking bay was filled with anxious people—friends, relatives, and station personnel—wondering about the status of the ship. As they came in for final approach, Jake went back outside to fire the reverse jets manually. As the *Urshanabi* drifted towards the station, the docking crew had time to realize that they were not responding to their radio calls and that something was wrong. They came out with a small repair craft to get her; the *Urshanabi* would not have been able to dock easily without the computer.

Jake and Shamita's entrance into the docking bay was met with a wave of applause from the already disembarked passengers, as whispered rumor spread about what had happened. They had no time to enjoy it; they were whisked away by the station manager and a slew of company officials for a debriefing. Jake barely had time to tell Ron that he'd contact him later, when he was free.

The next station day, after a good night's sleep, Jake sent a message to Ron's hotel room to meet him for a drink that afternoon. A few hours later, Jake walked into the Moonlight Lounge, a split level bar in the low-gee ring, with one large picture window always facing the Moon. A low murmur of conversation filled the empty space, bouncing off the metallic walls. A few people looked up and smiled at him, but he didn't see Ron.

"Hello, stranger." Jake turned around. It was Liz Hirsch, owner of the bar and an old friend. She gazed at Jake with brown eyes and twirled a strand of her curly black hair in one hand. Her other hand held an old fashioned beer stein.

"Liz! Heard about our exciting little trip?"

She cocked her head. "Are you kidding me? Everyone's been talking about it."

Jake shrugged, trying to appear modest. "Listen, Liz, I'm here to see—"

"Your brother. He's over there." She stopped playing with her hair and pointed over to the window; Ron sat at the table closest to the glass, facing away from the bar and into space. "Everyone's talking about him too."

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"Thanks, Liz. I'll have my usual." He headed over to his brother's table.

There was only one other seat at the table, the one facing away from the window. As Jake settled into the comfortably molded chair, Ron's eyes lit up in delight.

"*You're late,*" he signed.

Jake checked his watch. "*Only a few minutes. How are you feeling?*"

"*Fine. I had a great time on the U-R-S-H-A-N-A-B-I.*" Ron smiled as he quickly fingerspelled the name of the shuttle. "*Your friends let me fire the rockets.*"

"*I know. I found that out during the debriefing.*"

"*Really? What happened?*"

Jake told his brother how he and Shamita went through the details of the sabotage over and over with different company bigwigs.

"*Did you tell them about me?*" Ron asked.

Before Jake could reply, Liz came over with a glass that matched Ron's, and set it down in front of Jake. "Vodka martini. Better not be piloting for the next few hours."

Jake winked at Liz. "Don't worry, I know the rules," he said as she strolled away. Then he turned back to Ron. "*What were we talking about?*"

"*Me!*"

They both laughed, and then Jake felt somber. "*Ron, I don't know if you realize this, but I was always a little jealous of you as we were growing up.*"

"*You? Jealous of me? Why?*"

Jake felt his face flush. "*Because you were deaf, and I wasn't. You always seemed to get all this special attention.*"

Ron gave his brother a look of disbelief. "*Jake, it's not the easiest thing in the world, being deaf.*"

Jake nodded. "*Oh, I know that now.*"

"*Besides, if anyone has anything to be jealous of, it's me. After all, you're living the life I always wanted.*"

Jake scratched his head and looked away for a moment. "That's what I wanted to talk with you about," he whispered aloud.

Ron waved his hand in front of his brother's face. "*Hello?*"

Jake smiled, put his fist at his heart and moved it around in a circle: the sign for SORRY. "*My apologies. I've got something important to tell you.*"

Ron nodded. "*What is it?*"

"*Well, during the debriefing I told them all about how you helped us through the crisis. And—and I suggested something to them.*"

"*What?*"

"*It occurred to me that astronauts could use Sign to communicate in space when radios go out.*"

Ron leaned back and laughed. "*Is that all? You're not the first one to think of that. The first American space agency, NASA, tried to teach Sign to their astronauts. Didn't get too far, though.*" He grimaced. "*They didn't think it was worth it.*"

Jake took a deep breath. "*Well, after this emergency, it may go farther. Ron, how would you like a job teaching Sign to astronauts?*"

Ron shrugged. "*I already have a job teaching Sign.*"

"*I mean, a job here in space.*"

Ron looked puzzled, and curled his right index finger down: the sign for HUH. "*Space?*"

Jake nodded. "*Most astronauts don't get down to Earth anymore. They'd need you to teach the ones who are already here.*"

It took a moment to sink in, but then Ron smiled. "*We could work together!*"

Jake shook his head. "*I already know Sign, and besides, they need me here. They would need you to teach Sign somewhere else, in an environment where people might really find it useful.*"

"*Really? Where?*"

Jake turned around and looked behind him, out the window at the Moon. He closed his eyes, and imagined seeing beyond it to the planets of the outer solar system, which lay ahead. The deep

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cold vacuum near Saturn, Neptune, Uranus, and Pluto was the most silent environment humanity had reached so far. Right now, astronauts were constructing orbital stations and establishing beachheads, pushing the frontier further and further out. Jake wanted so much to be a part of it, but knew he couldn't. Oh, he could have offered himself up as the Sign teacher for those astronauts, but he knew he would never forgive himself. He had already had his opportunities; this one was not for him, but for Ron.

He turned back to his brother and did his best to paste a smile on his face. "*You were always the one who wanted to be the space explorer. Here's your chance.*"

Jake saw the glint in his brother's eyes as Ron finally caught on. They smiled at each other, and raised their glasses in a silent toast.■

IN TIMES TO COME

Author W. R. Thompson leads off our September issue with "Roundup," a new novella in his "Kya" series. It might seem that very alien species would have little use for the same piece of real estate because their needs would be so different—dolphins and camels, for instance, like very different places. But it's not necessarily that simple, especially when technologically assisted intelligence is involved. (Just ask any of the many species which have been crowded out by *Homo sapiens*, who can think of a use for just about anything he can get his hands on!) Thompson has imagined here quite a novel kind of conflict, with an equally novel solution.

Our fiction will also include new entries in popular series by Michael A. Burstein and Bud Sparhawk, a brand-new story by Charles L. Harness, and a couple of impressive debuts by promising new writers. *Analog* regular Daniel Hatch provides the fact article, "Spacebiz 101," a hard look at the numbers surrounding the question: when—and how—can space pay for itself?

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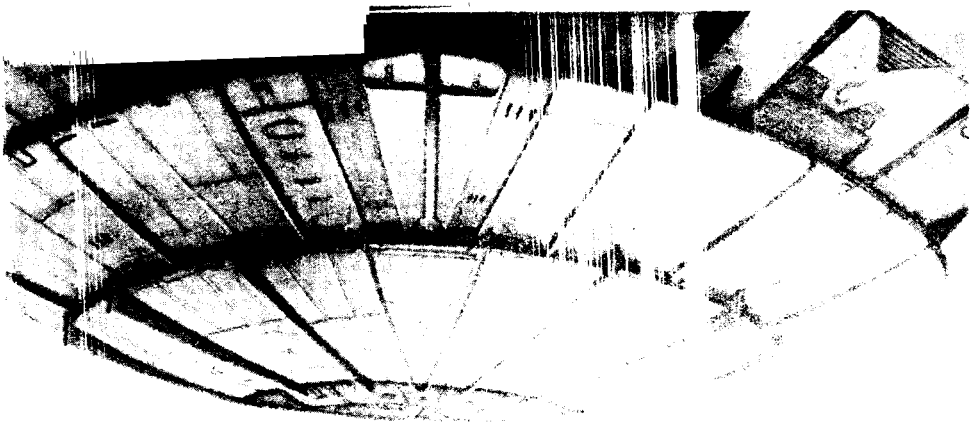

Conclusion

Joan Slonczewksi

The Children Star

That old saying, "You can never go home," in this case took on a very new meaning. . . .

Illustrated by Darryl Elliott

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SYNOPSIS

On the planet Prokaryon, all living organisms grow in rings. Tire-shaped zoöids graze over fields of loopleaves, and flyers with helicoid propellers fill the forests of arch-trunked singing-trees. As yet, none of these life forms have shown signs of intelligence; but the forests and fields are spaced in orderly arrays that imply the existence of "hidden masters."

Prokaryan DNA is triplex, and the biochemistry is full of native structures toxic to humans. To live there, human colonists have to be "lifeshaped," genetically engineered by the ageless Elysians who dominate interstellar trade. Lifeshaping is most successful on infants, whose physiology is immature and could be altered more easily than in adults. Thus, Prokaryon has been colonized mainly by children, and by sentient machines. Some Elysian commercial developers want to terraform Prokaryon to make it habitable, though its native ecology—and any hidden intelligence—would be destroyed.

On Prokaryon a religious order, the Spirit Callers, has founded a colony of orphans rescued from the plague-ridden world of L'li. The colony is run by sentients, the ***Reverend Mother Artemis*** *and* ***Brother Geode****, and by the human* ***Brother Rod****. After years of genetic treatment, Brother Rod can live on Prokaryon without a protective "skinsuit," but he can still only eat imported food.*

As the story opens, Brother Rod and Brother Geode are returning from L'li with four new orphans to join the Spirit Colony. One of the orphans, 'jum, is already too mature for easy lifeshaping, and will need to stay many months on ***Station****, the sentient satellite that prepares visitors for the planet. Her treatment will tax the colony's resources. Brother Rod feels guilty, but knows that the Spirit called him to save her.*

Back at the Spirit Colony, a "tumbleround," a giant Prokaryan plant-animal ridden with insect-sized helicoids, has invaded the garden, and Brother Rod needs to dig the foul- smelling vermin out. Then he finds that the colony's sentient ***Doctor Patella*** *has had an accident, and has fallen down the side of a mountain where the children mine sapphires.*

Now, Mother Artemis tells him he will have to take sick children on a journey through the treacherous singing-tree forest to get treatment from ***Sarai****, a reclusive xenobiologist who lives in the mountains. Sarai warns that her own xenobiology research has produced clues to the identity of the "hidden masters," the mysterious intelligent race that manages Prokaryon's climate.*

Most of the research in xenobiology is actually going on at Station, where sentients and graduate students are attempting to communicate with various species to prove that they are the "hidden masters." Rod is skeptical, because the scientists have claimed to communicate with Prokaryan creatures many times before, but it came to nothing. Nonetheless, to earn money that the Spirit Colony desperately needs, Rod signs on to assist the field work of a xenobiology graduate student, ***Khral****. Khral works for Elysium, but her parents were gorilla hybrids, former slaves on a less developed world.*

Khral's theory is that singing-trees use symbiotic "microzoöids", ring-shaped Prokarkyan microbes, to generate messages and transmit through light. She and Rod climb up the singing-trees to collect their lightpods, which contain the light-emitting microzoöids. Khral, unlike Rod, has to wear a skinsuit, an expensive, technologically complex sheath to filter out the planet's toxic chemicals.

In the distance, they catch sight of a starship entering the atmosphere. The

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ship crashes. It turns out to be a ship of illegal immigrants from L'li. If any passengers survive the crash, without skinsuits they will soon die. A friend of Rod's, the corundum miner ***Diorite****, searches the crash site for survivors. Oddly, he finds only the tracks of tumblerounds. Rod wonders about this; he urges Khral to study these plant-animals.*

At Elysium, there are renewed calls to terraform Prokaryon and make a place for impoverished immigrants to go instead of crashing on their own world—which is becoming an increasing embarrassment. ***Nibur Anaeashon*** *is the chief executive of Proteus Unlimited, a manufacturer of sentient-proof machines; he wants to terraform Prokaryon in order to mine it more efficiently. Nibur convinces banker* ***Iras Lethesbon*** *to finance a plan to terraform just one continent, Spirilla. Iras's mate is* ***Verid****, the Secretary of the Free Fold, the highest position in the interplanetary government. Secretary Verid is deeply upset by the plan; but she can offer no alternative measures to help settle L'lite immigrants, nor to halt the plague and end their starvation.*

Meanwhile, Rod is staying at Station to look after 'jum while she is lifeshaped. 'jum has shown antisocial behavior, perhaps caused by her traumatic past; but she also shows signs of an extraordinary gift for mathematics. When Rod returns to the mountains to pick up a child she treated, he introduces 'jum to Sarai. Impressed by 'jum's ability, Sarai reveals her culture of microzoöids that emit pulses of light in prime numbers. Sarai does not tell what creature her microzoöids came from, but she is persuaded to share the culture with Khral.

Khral is annoyed because a local epidemic of "spacer's spit-up" requires her attention. In her spare time she has found that Sarai's microzoöids grow, not in singing-trees, but in tissue extracts from a tumbleround. Perhaps tumblerounds are intelligent; they send the microzoöids to communicate. Alarmed, Rod asks if the microzoöids can infect humans. Khral tells him that human biochemistry is toxic for Prokaryan microbes.

At last 'jum's lifeshaping has progressed enough for her to join the Spirit Colony, living in a specially filtered room. Unfortunately she fails to fit in with the other children, only throwing stones at them. Mother Artemis wonders what to do with her. Rod again feels guilty that he saved her, instead of letting her die in peace.

The Spirit Colony learns of Nibur's takeover of their planet. A representative of Proteus Unlimited tells them they will have to relocate to another continent, so that Spirilla can be terraformed. The Spirit Callers are shocked. Reverend Mother Artemis departs to visit Secretary Verid and protest. Though Verid sympathizes, she can only order a temporary stay on the order to move.

Rod and Geode face 'jum's trouble, and the colony's uncertain future. Then Rod is troubled by dreams of Khral. As a Spirit Caller, he must not long for a human lover; yet he cannot stop thinking of her. Brother Geode advises him to meditate in the wilderness. So he goes out alone into the field of loopleaves, where he meets a giant tumbleround. His mind becomes confused and he experiences a strange vision of a hand. Is it a message from the tumbleround?

Unexpectedly Sarai calls the colony. She demands they send her 'jum, as an assistant for her work. Rod at first refuses; but 'jum wants to go. Rod sends the traumatized child, thinking, she was no better off at the colony.

Sarai shows 'jum what she has learned of the "language" of the microzoöids. She tells 'jum that the microzoöids were not found in tumbleround; the truth is much worse. Before she can explain, Sarai is interrupted by a call

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from Proteus, ordering her to leave the continent; Nibur himself will help her relocate her important studies. Sarai refuses to go and warns Nibur to stay off the planet—or he will never leave alive.

The terraforming, or "cleansing" of Spirilla begins, as stellar energy is poured onto an island, steaming it to kill all native life. The Spirit Colony prepares to relocate. Rod takes two of the lifeshaped babies up to Station for checkup. Khral tells him that the epidemic of "spacer's spit-up" has spread in an odd pattern: it strikes only travelers attempting to board a spaceship and leave Prokaryon. Meanwhile, she has discovered that tumblerounds transmit their microzoöid messages through whirrs, tiny insect-sized helicoids that hover incessantly above the tumbleround. Rod wonders again about the tumbleround he saw, and whether the whirrs might have infected him.

Meanwhile Nibur and the banker Iras have arrived on Prokaryon to supervise the "cleansing." On their way back, as they try to board their starship, the two Elysians fall ill with "spacer's spit-up."

In Sarai's laboratory, she and 'jum have decoded a number of "words" from the light signals of the microzoöids. They discover that the microzoöids themselves are intelligent; they make their home in a tumbleround. Because the microzoöids are so small, no one ever tried to communicate with them. But they can hide themselves within silicate capsules and grow inside human bodies. Fearing infection, she and 'jum flee to Station.

As more starships arrive to inject steam into the planet, strange thunderstorms appear; storms timed precisely to knock out the ships as they enter the atmosphere. The Spirit Colony has one day left to leave home, staying temporarily at Station. Rod and two older children decide to escape and help the planet's "hidden masters" fight back. In the forest they come upon a gathering of tumblerounds. They experience visions; somehow the tumblerounds make letters appear in their brains.

Rod and the children are found by Khral, now collaborating with Sarai at Station. They have discovered that spacer's spit-up is caused by microzoöids trying to escape from humans before they leave the planet. But for some reason the Elysians, Nibur and Iras, have sickened worse than other patients.

Rod tells the scientists of his visions; the microzoöids have infected him and they are trying to communicate through his brain. Station asks Rod to enter a starship as if to leave Prokaryon. He will trick the microzoöids into revealing their presence in his body; then the medical doctors can figure out how they work and cure the Elysians. Rod agrees; but Khral becomes upset, telling him not to endanger himself. He realizes she has fallen in love with him, and he feels torn between her and his spiritual mission.

When Rod tries to enter the starship, the microzoöids tell him to stop. They control his vision, revealing their presence in his cerebrospinal fluid. After living in his brain for so long, they have learned how to manipulate his senses, causing pain or pleasure. Fearing the worst, Rod asks Station for a lethal drug to take in the event he loses control.

The leaders of the Free Fold hear that an intelligent plague threatens humans on Prokaryon, and may have spread to other worlds. They instruct Secretary Verid to attempt to communicate with the microzoöids, through Rod and other carriers, to learn their weaknesses and find out how far they have spread; then Prokaryon will be destroyed. Verid protests this underhanded assignment, but she agrees to go.

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CONCLUSION

CHAPTER 19

In critical care, deep within the sentient Station, Nibur Letheshon began to waken. The Elysian tossed his head feverishly as he floated in and out of consciousness. For how long, he had no idea; he knew only that frightful phantoms crossed his eyes, shapes and forms unknown, like a virtual seascape gone mad, the waves rolling and cresting beneath him until he crashed upon the shore. All the while his hand clutched the collar of Banga, the dog standing there steadfast by his bedside, his ageless companion, now his only comfort amid torment.

As his mind cleared, the phantoms finally dwindled. Only a headache lingered; a nuisance, why could these provincial medics not clear it out? Once again he mastered his vision, clearly seeing the bed with its crude hospital covers, and the primitive servo analyzer of bodily fluids standing nearby. He shuddered; a wonder he had recovered at all, in this barbaric outpost. Why had they not sent him back to *Proteus*, where he maintained his own up-to-date clinic custom-designed for himself?

In his hand he held an empty collar. Curious. Why would they take away his beloved Banga, yet leave the collar?

A doorway appeared in the wall, opening to admit a hideous caterpillar of a sentient. Nibur's face froze as he drew himself up.

"You are much improved," the sentient brightly observed. "All your vital signs confirm."

"Why was I kept here?" Nibur demanded. "Why was I not sent back to *Proteus*?"

"*Proteus* told us it lacked any treatment program for alien microbes."

Alien microbes. His flesh crawled. That mad Sharer in the mountain, on Pavonis Three—had she cooked this up?

"Not that we had a treatment either," the miserable sentient explained, "but we have researchers with . . . initiative."

"Initiative be damned," he muttered. "If I suffer any lingering effects, you'll hear from Proteus." He held up the collar. "Where is Banga?"

The sentient's caterpillar head bobbed moronically. "I'm very sorry. Your dog passed away two weeks ago."

Nibur frowned. "Impossible. I've had him by the bed, all this while."

"A virtual image: You kept calling for him, and his presence kept you calm."

The first moment of fear that this might be true penetrated his mind. Banga—his companion, that had followed him faithfully for centuries. Banga—reduced to a virtual phantom? "No," he said hoarsely. "You imbecile machine, it can't be so. Banga is immortal."

"Banga succumbed to the same infectious agent as yourself and your fellow traveler. The medical staff deeply regrets our inability to save him. You may take comfort, though, that his death under our experimental treatment probably saved your own life."

Banga . . . A wordless scream echoed down the corridors of his mind. That world with its vile contagion had consumed his own companion. For a moment Nibur wished he had not awoken.

"You are free of infection now, so far as we can tell," the sentient assured him. "You may transfer to *Proteus* now."

"The sooner the better," said Nibur, breathing heavily.

"Prokaryon is in quarantine, but your firm has obtained a special exemption. . . ."

Nibur no longer listened. He would be off soon, and he would know what to do. That world with its cursed alien scenery would not long survive his dog.

In the laboratory, halfway across the satellite, little 'jum counted off the flashing lights from the microzoöids in her brain, while Sarai worked feverishly to assign their patterns names and symbols. Now that both the Elysian patients were out of danger, Khral renewed her effort to contact the microbial intelligence. She scanned her own database

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on the holostage, while Sarai clucked incessantly with her clickflies, whose webs now spanned half the lab.

Together, they had worked out how the microzoöid sisterlings named the chemical parts of their cells. The microzoöids seemed to name their elements in the order of frequency. First came hydrogen, then carbon, oxygen and nitrogen, as in humans; but thereafter, instead of sulfur and phosphorus, came arsenic. That was one reason Prokaryan settlers had to be lifeshaped.

So methane, CH_4, was *4 1*, while ethanol, C_2H_6O was *6 2 1*. But what to make of the bizarre cyclic amino acids in their proteins, like azetidine with its four-carbon ring? 'jum watched the model of azetidine hover over the holostage, a tight square of carbons with one nitrogen corner.

By now playing the light pipes was second nature for 'jum. The sisterlings were her friends. If only she could figure out more of what they were telling her.

"Hypoglycin, and mimosin," announced Khral. "Cyclic amino acids—you find them in some of our exotic plant species, but never in human proteins."

'jum reached above the holostage to place more numbers: *7 4 2 1 0 9 0 3*.

"That's azetidine," said Sarai. "The first four digits count the atoms; the rest designate the heterocyclic square, and the carboxylic acid."

"That's azetidine acid—the square amino acid they use instead of proline, to make kinks in their proteins." Khral patted 'jum on the back. "Those microzoöids are working pretty hard today. They're telling you a lot."

'jum nodded. "They ask me things, too. About everything around us, what it's made of."

"Tell them nothing," boomed the ever-present voice of Station. "We must keep them under control."

Sarai glared at the ceiling. "Wouldn't *you* want to know what your habitat is made of?"

'jum had already told the sisterlings the simple polymers that her clothes were made of, and the mineral of the starstone at her neck. But Station had refused to let her tell them other things, like the composition of nanoplast, even the floor and walls that surrounded them.

"I knew we should never have come out to this dimwit satellite," Sarai sighed. "We'll get nowhere."

"Khral," Station announced, "you are wanted immediately back at intensive care. New patients have arrived from Valedon and Bronze Sky."

Astonished, Khral stared at the ceiling. "From where? What are they doing out here? We've sent all we know to Science Park. They'd get much better care."

Station declined to reply.

"Innocent fool," muttered Sarai. "The carriers are outcasts. Anybody with microzoöids is getting sent here, like a leper colony."

"Because we can provide the latest treatment," corrected Station.

"Believe that, and you might as well join the clerics."

Khral said quietly, "I wish I could. Station, how many carriers are there?"

"A dozen so far. Some have had recurring 'visions' for weeks, perhaps months. No one knows how far it's spread—and whether whirrs have spread too." That was the key question. If whirrs had spread to other planets, there was no containing the epidemic.

"A dozen." Khral sighed. "I can see my work cut out."

"The orders are to try nothing fancy—just eliminate the silicates, like you did for Iras and Nibur."

"That's as good as murder," said Sarai. "Even the cultured ones are languishing." For some reason, the microzoöids in the culture vessels had stopped growing, probably starving for an essential nutrient. "They need a live host. Keep them in the carriers."

"Right," said Khral. "It would make more sense to talk to them."

Above the holostage, the medical

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sentient suddenly reared its limbs, spouting test results. "You see what bad shape these carriers are in? How can you *talk* to a pathogen?"

"All right, I'm coming," called Khral. "Sarai, I'll send you whatever communications the nanoservos pick up in the patients' brains, and see what you can make of them." Picking up her self-sterilizing suit for the clinic, she left.

"Talk to them, indeed," muttered Sarai. "When Station won't even let us answer what *they* ask of us! What's the use?"

'jum agreed. If only Mother Sarai would take her back to the cavern. The sisterlings inside her head would be happier, too. Like her, they felt trapped—and they were doing something about it. *1 0 2 0 0 7 1*, they said. This sequence she had first seen when Sarai had transferred sisterlings from one dish to another. It seemed to mean "moving" something from one place to another; or "travel"?

Sarai rose and stretched. She clucked twice, in the language she used to call the clickflies. "What do the sisterlings want now?"

'jum closed her eyes and tried to count the numbers that the sisterlings were posting inside her eyes. "Everything," 'jum clucked back. "What everything is made of."

Station did not respond. Perhaps Station was not attuned to clickflies.

"They could help us," muttered Sarai. "Those sisterlings could help our lifeshaping, more than anything—a thousand times more than Stations's brainless nanoservos." She clucked again, and one of her clickflies sailed in the doorway. The splay-legged insect obligingly set to spinning a web in the corner. 'jum watched the web, trying to puzzle out the pattern of its sticky strands, woven straight and cross-wise, with some squares pasted together. Then she realized what it was: a molecule. The molecule was a component of Station's floor, some fancy kind of polycarbonate.

Now 'jum stared at her two light pipes, one in each hand, trying to translate the molecule as best she could into the sisterlings' number code. She had number combinations for methyl groups, esters, simple cyclics and so on, but the more advanced features remained a mystery. "More, more," the sisterlings flashed back.

"More molecules," clicked 'jum.

Sarai clicked rapidly to the insects. Their long legs flitted across the web, weaving other molecules: components of the expandable door rims, the ceiling, the air vents.

Abruptly the holostage fell dead. A bright light filled the room, making 'jum squint.

"What do you think you're doing?" boomed Station. "I told you not to tell those bugs what I'm made of. I could charge you with treason." In the corners the webs were dissolving into the walls, while the clickflies had vanished out the door.

"What do you think *you're* doing?" Sarai shot back. "Obstructing critical research. How do you expect us to learn anything, if we don't share information?"

'jum put her hands to her head and watched the blinking lights in her eyes. The sisterlings were talking again, about *moving* and *travel*.

"You foolish human!" cried Station. "The first deaths on Prokaryon were sentients—chewed up by microzoöids. Until we figured out how to build ourselves of stuff they couldn't handle. Have you no sense?"

The instruments dissolved into the walls, and the room itself began to lose shape, its corners filling in, everything collapsing into formless gray. Even the light pipes in 'jum's hands disintegrated. She was helpless inside Station, just as the poor sisterlings were helpless inside her.

Station said, "That is why I make the rules here—because humans lack common sense. You will remain in confinement, until further notice."

The Sharer took a deep breath. "You

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bring back that door, or we'll teach them to eat you alive!"

Sarai's voice cut off oddly without reverberating, as if not even sound could escape. There was no response. Around them rose four gray walls as square as azetidine, but with no distinguishing corner. The walls joined a ceiling with an indistinguishable floor, creating a pallid gray cavern.

The only spot of color was purple Sarai, crouching on the floor. But her fingertips were turning white. "'jum, I can't take this. You know what I must do. I will be all white and cold; don't be afraid, I will gain wisdom from my ancestors. Khral will come for you soon enough; she won't let you go without dinner."

'jum watched as Mother Sarai whitened, the purple breathmicrobes bleaching out, while the veins appeared through her skin. She wondered how Sarai managed such deep concentration. She herself had no breathmicrobes, but perhaps she could learn to concentrate, and better hear the little sisterlings. So she sat on the floor, like Sarai, her legs crossed and her back straight. She closed her eyes, took a deep breath and relaxed.

1 0 2 0 0 7 1, said the sisterlings again. *Let's travel.*

Where do you want to go? 'jum wondered. She wished she had her light pipes. Her hands flexed as if she still held them.

1 0 0 0 0 0 9 0 8. The sisterlings spelled out an answer, as if they had heard her anyway. As if they heard now, in her brain, what she was trying to signal. The number they made in response had appeared before, when 'jum looked out Station's observation deck.

1 0 0 0 0 0 9 0 8, the stars.

The stars. Will you take us?

The stars. That was where 'jum had always wanted to go, and Brother Rod finally took her there. She would go again if she could. But just now, she couldn't go anywhere.

Never mind. If my generation doesn't get there, my children will.

* * *

On the holostage in Rod's room stood Geode and Three Crows, each with a plump baby in one arm. The scrawny infants from Reyo had grown into crawlers eager to get down and scoot across the stage. Geode extended an eyestalk to Rod. "We're all praying for you," Geode told him. "May the Spirit heal you soon."

Rod made himself smile. What did "healing" mean any more, he wondered. The death of a million microbial aliens, to save his own life? "Do the children have what they need? Is T'kun getting his medicine?"

Three Crows shifted Qumum from one arm to the other. "I wish I got what *I* need," said the tall Bronze Skyan, "another four arms, like your brother here."

Rod traced a starsign. "You were just what we need, a gift from the Spirit."

"The children are fine," said Geode, "but they all hope you'll come home soon."

"What home?" The words slipped out before he thought.

Geode's eyestalks reached around in a circle. "Wherever we all are, that's home."

"Wherever Mother Artemis is," said Three Crows. "Tell Elk I'll call him, after the kids are in bed."

That evening, Elk joined Rod in his room for supper. Rod clasped his arm gratefully. "It's so good of Three Crows to help us out."

Elk shrugged. "He needed something to keep going. He's in quarantine like the rest of us." The scientist watched his dinner appear out of the wall, his large fingers flexing pensively. From the foot of the bed the cell sorter bleeped, spouting lines of data to Station.

"Has the infection spread through the ship?"asked Rod.

"Not since Station tightened all her air filters. Only whirrs can spread the microzoöids outside a host, and now not one can get through. Station has shipped out most of the colonists,

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except for carriers we couldn't clear, and those who . . . chose to stay."

Rod tried to swallow his own food, barely knowing what he tasted. "Have any of the other carriers . . . seen what I have?"

"Several have seen signs," said Elk. "They happen to be trained in meditation of one sort or another—as you are. It must help you 'connect' with the microzoöids."

"But some of the carriers are ill."

"We'll try to treat them, as we did the Elysians." Elk avoided Rod's eye. Little good the "treatment" had done him.

"What about 'jum?" Rod asked suddenly.

"'jum's microzoöids behave differently from yours. They don't make threats." He brightened with a sudden thought. "You know, it's like different human cultures on different planets. 'jum got the Sharer microzoöids, whereas you got the Valans. No offense."

"But what if hers change? How can she resist them?" Tossing aside the covers, Rod swung his legs over and stood up.

"What are you doing?"

"'jum is my child. I want her cleared and returned to the colony."

"But—Rod, you can't just . . ."

He reached the wall and pressed it with his palms. There was no door, and none formed. The clear, blank expanse faced him, suddenly terrifying.

Station said, "You're ill yourself, Rod."

His hands became fists, digging into the wall. A curse went unspoken, then he withdrew his hands. The indentation reshaped itself smooth, while Rod returned to sit on the bed, which had already remade itself. "I will pray for 'jum."

Elk looked down, unable to speak, his face deeply creased. Then he thought of something. "We just heard—Secretary Verid will be here tomorrow. The Council voted to test the microzoöids for sentience. So the planet's safe from cleansing."

Rod pushed his meal back into the wall. "The secretary will first have to convince those microzoöids that we're even worth talking to. Maybe the Elysians were right; if we don't wipe the bugs out, they'll make llamas of us all."

Elk's large hands shook and he put down his fork. "I don't know. I'm a plant person; I stayed away from medical training, never wanted to work on people. And now—" He stopped.

"How's Khral?" Rod asked softly.

"She thought you wouldn't want to see her again."

"I wanted to apologize."

"As for me, I'm with you, Rod. I wouldn't want to be the slave of some microbe."

After dinner Rod lay on the bed with his eyes closed. Sleep would offer respite from this nightmare; but what would the invaders do to his brain as he slept?

He heard the sound of a door puckering open, and a breath of air reached his face. His eyelids fluttered open, and he saw someone walk in. In the doorway stood Khral, hesitating.

Rod sat up quickly. "I'm sorry," he said. "I shouldn't have—"

"Bother. It was stupid, what I said."

"You were right. Obedience is a virtue." A virtue he had cultivated for years, first at the Academy, then with the Spirit Callers.

Khral came to sit by the bed. Rod wished he had had a chance to freshen up first. "Obedience to what is good," she said, "not the blind obedience of a slave. My grandparents were the children of Urulite slaves. They scraped a living out of a patch of hillside, saving enough to educate their children. My parents left Urulan for Bronze Sky, where they founded the Simian League. Their speeches were on every holostage—I think they expected me to marry a gorilla, God knows. But I just wanted to be me." She looked wonderingly at her hands. "The secret of life; it always fascinated me. I look at myself and think, I'm an animal, and yet a human being. It's extraordinary."

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"Any of us could say the same."

Khral looked at him. "That's exactly what I mean. You always understand, Rod."

He touched her hand. An infinite sympathy seemed to pass between them. He burned with longing, and despair. How could the Spirit let him care so much for a half-breed student?

Something brushed past Rod's face, a tiny insect. It sounded like a whirr.

Khral caught sight of it. "How did that whirr get in here? Station," she called. "Better check your filters."

"I will," called the voice, steady as always. "I will recheck all my filters, and decrease the pore size again."

Withdrawing her hand, Khral reached upward and scooped the whirr out of the air. "We'll see what these 'sisterlings' are up to." She dumped it into a collecting vial.

Astonished, Rod stared at her bare hand with which she caught the whirr. How brave she was. He himself was infected and had no choice, but she chose to keep up her science when she could have kept herself safe. He doubted he would have done the same.

Chapter 20

Late at night Rod awoke. The room was dark except for the faintly glowing button on the blood monitor. But in his eyes, the lights were blinking again. The microzoöids were up to something.

ANIMAL. MEN READY. YOU MUST GO.

Rod watched the letters shape themselves. *No,* he thought back as hard as he could. He would not be a beast of burden for these rude creatures.

MEN MUST GO HOME. GO HOME NOW.

That sounded hopeful, Rod thought. *Go ahead, leave.* Let the whirrs come and take them all.

YOU TAKE US HOME, NOW.

Rod opened his mouth to call Station for help—but no sound came out. He could not speak.

GO HOME NOW.

The first twist of pain entered his head. He could not cry out. What would the microscopic tormentors control next? He reached out and felt for Station's deadly tablet on the shelf by the bed. At last his hand found it.

He prepared his mind just in time to meet the full wave of pain, searing, tearing every fiber of his body. Before his eyes arose the image of the old master of the Guard, a Sardish colonel with a beard as sharp as his epaulets. *Resist,* the master commanded. *You will resist, or die.* The hypnotic impact of that image held him above the pain. Centuries seemed to come and go, and still the pain burned. When the master's image faltered, Rod's hand closed around the tablet.

But then another shape arose—Mother Artemis. *Live,* she called to him. *You shall live.* Just like the day he first saw her, meditating in the park outside the Academy, where Rod had wandered out after a particularly dissipated weekend. Her look that day had touched a place in him that even the Sardish master had never reached. *Follow me, and you shall live.* He had followed, and never looked back. Now, despite the torment, his hand loosened; for the Spirit yet called him across tens of millennia, called him to live through the worst extremity.

When the pain did not seem as if it could possibly get worse, it did. Again the master's image returned, ordering resistance; and then again, Mother Artemis called for life. Always one or the other, until the pain would shatter his head into a thousand fragments.

Then, after eons of torment, the pain died. Rod sat up, drenched with sweat. The tablet remained in his hand, and he still had not yet squeezed the death out of it. He had actually beaten the microbial masters—this time. There was silence, and darkness, his eyes at peace. Slowly he let himself back down on the mattress, his breathing returning to nor-

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mal. Nothing was so welcome as lungs full of air without pain.

ANIMAL GOES HOME. The infernal letters returned. ANIMAL GOES; WE REWARD.

Rod did not deign to reply.

Then slowly his limbs filled with pleasure, more intense than he could ever have imagined. Too late he tried to cry out, for he had no defense. He could only drink it in, like a plant drinking water from the soil, grateful and despairing. Nothing in his own miserable existence could compare with what the microzoöids gave, none of those he loved, not even the highest communion with the Spirit.

It was gone all too soon, leaving him sick with craving. He turned restlessly, until the covers fell off. He found himself thinking of the lightcraft, and how to get back down to Prokaryon, while another part of his mind screamed at his madness. He had no intention of getting up, yet he found himself swinging his legs down over the side. He told himself, getting up for a moment would do no harm.

The pleasure began to return. Then he realized that he would do anything the microbial masters demanded, even sell his own children. He groped frantically for the tablet, which had slipped from his fingers. At last his hand caught it and squeezed hard.

Gradually Rod awakened, to a room full of morning light. Confused, he wondered where he was and what had happened. His head turned, and he saw someone seated nearby. With an effort he focused his eyes and saw Mother Artemis.

The shock chilled him. "How am I still alive?"

"Did you think Station would let you come to harm?"

So that was it. Tricked by that lying sentient. But the Reverend Mother must know, that he had tried to end his own life, the worst of sins. He turned his head to the wall. "Mother, I am not worthy to face you."

"Brother Rod, you are forgiven absolutely. Think of it no more."

"I am not forgiven. I am better off dead."

Mother Artemis paused. Rod could imagine her behind him, her all too familiar face screen with its compelling gaze. "Once, Rod, you asked the Spirit to grant you a world. Do you remember?"

He shuddered. "I am not the man I was."

"Now, all the worlds of the Fold depend on you."

Rod swallowed hard. "'jum can help you better."

"'jum has entered some kind of trance. Not whitetrance, like Sarai, but she will not communicate."

So much for "Sharer" microzoöids, Rod thought bitterly. Who could tell what they were doing to poor 'jum? Far better had he left her that day on Scarecrow Hill.

"There are other carriers, but none as advanced as you. Please, Rod—won't you try again? Secretary Verid has arrived to talk with them."

"It's too late," he whispered. "There is nothing I can do. Please, leave me." No need for her to see what the microzoöids could do to him.

He lay there facing the wall, for hours, perhaps days for all he could tell. Drained of emotion, all he could hope was to think of nothing, no pain nor desire, and hope the tormenters within kept quiet.

A faint swishing sound came from the wall, and a breath of air touched his neck. Some one must have opened a door to look in on him. Rod listened hard, but did not hear the door close. The minutes ticked by, and he wondered, had the visitor left, or were they still there? He grew uneasy. At last he turned his head, just far enough to see.

A small woman in a leaf-brown Elysian talar sat near the door, her back toward him. He frowned, wondering why she

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looked familiar. Then her head half turned, and her profile leaped out at him from a thousand holocubes.

Hurriedly he sat up straight. "Honorable Secretary."

"Brother Rod." Her voice sounded at once familiar, yet extraordinary, to be addressing him in person instead of from a newscast. "Brother Rod, how can I face you. You, who offered your own brief lifetime that my Iras might enjoy centuries more."

Taken aback, Rod shook his head. "Whatever they've told you—I'm just a very sick man."

"And here come I, a cupbearer for murderers. I am covered in shame."

Rod blinked, wondering what to say. "You have all the humans of the Fold to speak for. What do I know of that?"

Secretary Verid turned toward him, and he faced her owlish eyes. Suddenly Rod realized what the Academy and the Spirit Callers had always shared: They taught disdain for politics. Obey your commanding officer, or your Reverend Father or Mother, and forsake the slimy machinations of the world. But here was someone who made the world her business.

"What you know may save countless lives. Shall we proceed?"

Rod swallowed. "What do you want of me?"

"We have seven days to convince the Council of the Fold that we can deal with the . . . alien intelligence. If we succeed, they will suspend the planet's destruction."

He looked away. "I'm no longer sure that's wise."

"Indeed. Explain."

How could anyone know what he had undergone? He shuddered. "The microzoöids make us helpless. They can control us absolutely."

"You seem in control right now."

"They leave me alone, then attack at their whim."

The secretary thought this over. Even with her thousand years' experience, what could she know of these alien creatures too small to see?

"It's been twelve hours for you, hasn't it? Half a generation, for them. Did they get what they wanted?"

He considered this. "Not yet."

"Not yet, indeed. I can imagine what they're going through—accusations and recriminations, shifting the blame, 'who lost the human,' and so on. They must have sacked half their staff."

Despite himself Rod smiled. "Whatever comes next, though, will only be worse. They can't even think of us as people—they call us 'animals.'"

"And what do you call them?"

Rod frowned, puzzled. "Microzoöids?"

"'*Little animals.*'"

"Well that's what they look like."

"Just as you always looked like a llama, to them. Let's call them what you would like to be called—a man." Seeing his look, she smiled. "'Micromen,' if that's easier."

Rod shrugged. "As you wish, Secretary."

"Now tell me, what is it the 'micromen' want?

"They want to go back to Prokaryon."

Her eyes widened with astonishment. "Back to Prokaryon? Isn't that what you'd want them to do?"

"Certainly. But they want me to take them. And Station says we need to study them here, to help cure those infected."

"Ah, I see." Verid sighed and shook her head. "What a tangled web we weave. Well, I think now we're ready to talk. Can you contact them?"

Rod stiffened all over. "I can try. If I have to."

"It's absolutely crucial."

Taking a deep breath, Rod let his mind empty, as he had done so often for the Spirit. He wondered how long it had been since evening prayers. Now he prayed, out of a place of despair he had never known before: Whoever is out there, help me now.

He raised his hand and focussed his eyes upon the fingers. This was the sign the "micromen" had used before, and it

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was his best guess to summon them. For some time there was no sign nor sound, only the pounding of his own heart. He tried to envision his inner denizens as "little men," though he recoiled at the thought.

From the corner of his eye, a light flashed.

Rod closed his eyes. "Room darken," he ordered. The light from the ceiling dimmed, and Secretary Verid became a shadow.

Within his eyes the letters began to shape themselves. Panic seized him; he gripped the bed rail to steady himself. MAN . . . I SEEK TALK.

"They want to talk," Rod said aloud.

"There's a start," said the secretary. "Talk about what?"

MY BROTHERS NEED YOUR HELP.

"You tried that before. It was no good," he told them.

WAS DIFFERENT GENERATION. THIS GENERATION KNOWS BETTER.

Rod laughed. "They say 'this generation' knows better, but it's only been half a day. Khral says the elders live a month."

"That's all right," said Verid, "let them save face. Why do they need your help?"

Why do you need help? he silently asked.

BROTHERS ARE DYING. BROTHERS FROM ANOTHER WORLD, DEAD PLACE. WE MEN CANNOT GROW WITHIN A DEAD WORLD; ONLY WITHIN A LIVING HOME.

That was true of humans too. How long would humans thrive outside an ecosystem? "They say some of them are dying. Ones from 'a dead world.'" But what could that be? Had one of the patients died?

"How would they know?" asked the secretary. "They've been inside you for weeks, I understand."

"The whirr," Rod recalled. "The whirr must have brought them—from Khral's sick culture. That's the only place micromen would be growing outside a living body."

BROTHERS ARE DYING. WE CANNOT HEAL THEM; MUST RETURN TO TUMBLEROUND.

"Their 'brothers' need expert medical care," Rod guessed.

"Excellent," said the secretary. "A chance for a humanitarian gesture."

"But they would need a human body to carry them. Unless we find enough whirrs." A prospect unlikely to please Station.

Verid considered this. "I think we can arrange human transport. Most discreetly, of course." Humans were now banned from Prokaryon.

"I don't like it. They would think I gave in."

"You already proved you would not."

Rod closed his eyes. *"No pain, and no rewards,"* he told them.

NO PAIN, NO REWARDS.

"If I take you there," Rod asked hopefully, *"will you all go home—all of you?"*

There was a long pause. The secretary watched intently.

HOW CAN YOU SEND US AWAY? YOU ARE HOME TO US, MANY GENERATIONS. YOU ARE ONLY HOME WE KNOW.

Rod's eyes widened. "The ones growing inside me—they don't want to leave, ever." He caught his face in his hands. "Spirit save me."

"They don't want to leave," mused Verid. "By now, perhaps, few of them can. In any world, how few individuals have the courage to emigrate."

CHAPTER 21

'jum had long experience of shutting out a world of pain. Now, sitting entranced, she had the new lure of the world within, full of the sisterlings with their pulsing number codes. This one was flashing green: once, one pause, then twice . . . *1 0 2 0 0 7 1*, said the sisterling. (If you cannot yet help us travel, then we'll help you. Travel into our world.)

What is your world like?

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The numbers flashed, and she translated. (You'll see. Trust me; I am an elder.)

'jum focused on a tiny green speck of light. The speck grew into a ring, and the ring became a fat, healthy torus. Its surface was criss-crossed with a molecular scaffolding that held the cell intact. It extended loops of polysaccharide filaments toward 'jum, as if to caress her.

(My name is:) *1 0 0 3 7.* The whole shining torus flashed at her. (What is your name?)

'jum thought this over. *1 0 0 0 0 1 0 1*, she said, picking some of her favorite primes.

(A beautiful name, *1 0 0 0 0 1 0 1.* Your elders must love you very much.)

My elders all died, one after the other.

(Your elders died? Ours can live for thirty generations of children. How do you live without elders?)

Brother Rod brought me to the Children Star. Now, I have Mother Sarai.

("Mothers" we cannot understand. For a tumbleround, yes; but for a person?)

Another torus tumbled over, a blue one, looming near out of the dark liquid. Then came two yellow ones. As they approached, though, all turned green. (Our children.)

The green rings propelled themselves by pumping little jets of liquid this way and that. Two of them knocked together, then one managed to squeeze itself affectionately through the ring of the other. They tangled in each other's filaments, and blinked their light at each other, so fast even 'jum could not make out the numbers.

(We normally converse a thousand times faster than I do with you.)

When will your children grow up? 'jum wondered.

(She will grow up fast,) *1 0 0 0 0 1 0 1.* (In a couple of hours, she will be as old as you. She'll go to school, too.)

A new group of rings appeared, of various colors and sizes, all smaller than the adults. In their midst floated one elder, colored red. The elder flashed color insistently, and the smaller ones gradually adjusted, though they kept straying off a bit, here orange, there indigo. It was always hard to make children listen.

How do you eat? 'jum wanted to know.

(We take food through molecular pores in our sheath. The pores open wide when we like the food around us. And all our food comes from you! Please, feed us foods we adore, especially foods rich in mimosin and azetidine.)

I'll remember, 'jum promised, watching the children. *Do they tell stories?*

(We all tell the story of our people, the Dancing People, came to be. Long ago, in the Perfect Garden, our ancestors dwelt within a mindless world; a world to be controlled, to be led in its wanderings, to cultivate our planet full of worlds, but mindless nonetheless, indifferent to our desires. From other worlds came whirrs, bringing visitors, but one world to another was all the same.

Then the whirrs brought numbers about different kinds of worlds, grown with internal landscapes of harsh alien beauty. The Dancing People marveled. How could such world appear; where did they come from?

To seek answers, some of us took to the whirrs and braved the passage into the alien worlds. Many died, for the habitat was harsh and unforgiving, its physiology foreign to our control. But we learned and adapted. One of those worlds, *1 0 0 0 0 1 0 1*, became our beloved home.

Then we discovered an amazing thing: The alien world had intelligent feelings. You could in fact understand us, responding our most intimate desires. And most astounding of all, you came from the stars, like the very gods. It is a wondrous thing, to inhabit a god.)

In the laboratory, with the secretary beside him, Rod eyed the culture dish, a bauble of nanoplast connected to a dozen ports of gases and nutrients. Khral adjusted a connection, not looking at him.

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"Are you sure we can't just take the culture down to Prokaryon?" asked Rod. "They've lasted this long."

"They need constant adjustment of oxygen and temperature," Khral explained. "If I disconnect the culture, they'll die outright."

"The whirrs can't carry them?"

"The whirrs are like ambulances. They're well equipped, but you wouldn't want to spend months in them; you'd starve. Remember, the micromen live on a faster time scale."

"But these have never been inside a human," said Rod. "What if they're too sick to adjust to me?"

"Your own micromen seem to think they can stabilize their 'brothers' and keep them from dying off before we find a tumbleround."

The secretary touched his arm. "I'm convinced we'll impress your alien inhabitants with our humanitarian gesture. Once they're willing to listen, we can get them to agree to stay out of human bodies."

"The transfer will have side effects, but we'll protect you." Khral placed a nanoplastic patch on his neck. "The patch will send nanoservos into your blood, to keep you from running a fever when so many foreign visitors are transferred." Then she took a vial of whirrs and opened it into a connecting tube to the culture. As the valve turned, the whirrs swarmed into the culture, presumably picking up as many micromen as they could. Rod felt his scalp prickle. But the worst was yet to come.

"Vacuum suction," Khral called to the culture system. The whirrs immediately were sucked up back into the vial, which sealed itself as she removed it. Her hand shook slightly as she turned to Rod. "This may be easier if you don't look."

Rod looked away, his face turned to stone. He felt the round pressure of the vial against his skin, but surprisingly nothing more. Those whirrs certainly knew how to avoid irritating their host.

GREETINGS. WE WELCOME OUR BROTHERS.

Hush, Rod told the letters flashing before his eyes. *This will be hard enough.*

"I've known many brave men," said the secretary, "but none more than you. Well, Khral—are we ready?"

"Titer check," Khral called to the culture vessel. "Looks like a few left behind; we'll repeat the procedure, then we're done." She looked to the secretary. "I'll go down to the planet with him. If he runs a fever or anything, I can take care of it."

"Very well," said Secretary Verid. "You all understand—absolute secrecy."

"We'll take the old servo shuttle, so Quark needn't answer questions. It's been fixed up," Khral assured him.

The stripes of wheelgrass loomed through the window. It seemed so familiar, yet utterly strange to be returning to Prokaryon. So much that had been a mystery was now explained. Rod knew, now, who made the wheelgrass grow in bands; he knew, far better than he cared to, how Prokaryon's true masters governed the beasts that grazed the rows, never picking off so much as a shoot of a singing-tree in the forest. Yet despite how much had changed, within himself he could not shake off the sense that he was going home, and the loss of home ached all the more.

Khral pointed to the viewport. "There, near the river where the forest starts—I see a herd of four-eyes." Several of the tire-shaped beasts were grazing.

"The micros wanted a tumbleround, remember." The tumbleround had always been the preferred host; yet now, the micromen that had grown up inside him seemed to like an alien human even better. How could that be?

Seconds later the craft landed, more gently than it used to. It must have been fixed up well this time, Rod thought hopefully; then he remembered, there was no more colony to need it.

The ginger wind blew across his face

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as he stepped down. Khral had activated her skinsuit, and Rod remembered that she was not even lifeshaped for Prokaryon. "You can stay here," he told her. If she slipped and the suit failed, there was no help anywhere, not another human or sentient on the planet.

"Bother." Khral stepped down amid the wheelgrass. She always looked prettiest in her skinsuit, the sunlight sparkling from every curve. Rod recalled happier days, when the scientists went collecting singing-tree pods and watching the light show in the upper canopy; as it turned out, all telecommunications of the micromen. What had those little people thought of them, he wondered, these great human beasts lumbering through their forest, chopping off great hunks of their habitat to haul off in vessels unimaginably large.

Now, though, they had to find a tumbleround and get their errand done. Finding a tumbleround was not so easy, Rod realized with chagrin. Before, he had spent so much energy getting rid of them, but now he had no idea where to go look for one. "We might try the forest," he guessed. "I think they prefer the shade."

Khral nodded, the creases of nanoplast winking around her neck. She hiked with him toward the forest, where the first singing-trees arched overhead, loops upon loops of branches reaching outward. She stopped. "We shouldn't go too far; you'll tire out. Why not stay in one place, and let the whirrs find us?"

Rod leaned into the arch of a singing-tree, stretching his back. In the loops of the upper branches the wind sang, and helicoids clattered among themselves. The planet would be saved from destruction, Verid had said. Suddenly he felt very good; there was hope after all, and he was doing his part. "How is the lab?" he asked. "Are you making progress with the language?"

Khral rested next to him. "We figured out a lot, until Sarai went into white-trance. Now we can't wake her. One of your children could wake her, but Station said it wasn't right."

"For a change."

"And 'jum won't talk either, but I suspect that's just 'jum. You know her."

"All too well," he admitted.

"Damn that Station," Khral exclaimed. "If only she were more tactful."

"You can't blame her. After seeing what I went through, why should she let anyone help the micromen learn to live within nanoplast?"

Khral turned to him. "Rod—I can't bear that it happened to you. I wish it was me, or anyone else in the world."

Rod shrugged. "It had to be someone."

"Not you. You're the only man who ever looked at me like a human woman."

Startled, he looked at her. Was he that transparent, all this time? But the weakness that he despised, she praised. Her skinsuited face was so near; her eyes held him, until he thought he would fall in. He wanted to tell her something, but somehow could not find the words. He lifted his hand and caressed the nanoplast on her cheek.

Khral adjusted something on her suit. Its voice squeaked, "Suit alert, suit alert! You're in danger!"

"Hush," whispered Khral. "I've begun lifeshaping; I'll survive an hour." The suit slowly peeled, flowing down her face and shoulders, into a puddle of nanoplast at her feet. Her face was clear, her lips near enough to taste.

Rod felt the blood pound in his ears. He thought, I am a free man, not a llama; I will freely choose.

As he met her lips, her arms were around him, her fingers alighting on his back, the nape of his neck. He shuddered as her touch set him on fire. His hands remembered how to slip the clothes off as quickly as possible. Beneath his hands a fine fur covered her back, but her breasts were bare. She pressed herself to him, wanting him so badly, he prayed he could last long enough to please her. Nothing else exist-

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ed; they were one, alone in the universe.

Afterward they lay quiet together in the wheelgrass. The wind swept over them, and far overhead a flock of helicoids cried as they took off from a singing-tree. Rod let out a sigh of peace and despair. "*Spirit forgive me,*" he whispered.

He felt tears from her eyes. "Are you al right?"

"Yes. Was it good, Rod?"

Rod did not want to say how good. He would not fear the micromen again. He pressed her hair. "You are a beautiful woman."

"I knew it would be good. Oh, Rod—if we ever get out of all this, let me take care of you. I earn good pay, enough for you and any number of kids."

He let out a sigh. "Khral. Would you trust a life-long vow from a man who just broke one?"

Her face crumpled. "I hadn't thought of it that way." She looked at the starstone, lying cold on his chest. "Will you have to leave all those children?"

Rod nearly blacked out to think of it. Let the micromen come; their torments would drown his pain.

"How can it be," she whispered. "How can something that feels so right be so wrong?"

Something more than the wind brushed his arm. Several whirrs had come to settle, their tiny propellers humming.

"They're here at last," said Khral. "They'll take your sick micromen now."

Rod eyed the whirrs with suspicion. "The micromen—they were waiting for us." It was bad enough to break his vow, without a million "people" watching.

"They're good biologists," said Khral. "I'm sure they wanted to know how humans do it." She caught his arm as he started to rise. "Don't exert yourself. There will be lots of traffic in your bloodstream, new ones arriving and old ones leaving. Your immune system won't like it; you may run a fever."

New ones arriving—that was not part of the bargain, he thought. He lay back, watching the loopleaves flutter in the wind, trying not to think at all about anything. A scent of glue reached him. "Is the tumbleround there?"

"I see one, a ways off, in the arch of that tree." Khral pointed, her arm outstretched across her breast. She sat up, retrieving her clothes and her skinsuit.

In his eyes appeared something bright that was not sunlight. Closing his eyes, Rod found the message. WELL DONE. OUR BROTHERS WILL LIVE.

Rod sat up. "They say they're done. We can go now." As he started to pull on his shirt, an unwelcome sense of pleasure entered his brain. *"No,"* he said aloud, squeezing his eyes hard shut. *"I said, no rewards."*

HOW DO WE THANK YOU FOR SAVING A WORLD?

He blinked, then laughed aloud.

"What's going on?"

"Nothing, only my own foolish words. Let's go." He was starting to run a fever, but he could walk to the shuttle.

"I'll get lifeshaped,"Khral promised. "If it takes ten years I will. We'll be forever studying this place."

Rod said nothing. Lifeshaping looked easy, next to the choice that faced him now.

CHAPTER 22

Deep inside 'jum, the sisterlings danced. The little rings danced in intricate patterns, three crossing five and five crossing seven. Red and orange, yellow and blue, their paths wove to and fro, all the while blinking in songs that 'jum could not follow. (What about you,) *1 0 0 0 0 1 0 1*, they called. (Do you dance? Do the gods dance, too?)

'jum wondered. The Spirit Children never seemed to dance. Why not?

Outside her, some useless grownup was trying to bother her again.

Take me with you,1 0 0 3 7, she told the sisterlings. *Show me how to dance.*

(You are a god, and you must dance with gods. But never fear, we will always

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be dancing inside.) The patterns shifted, and the pulsing circles receded into the dark. 'jum longed to follow, but she could not. *1 0 0 0 0 1 0 1*—(to dance, we need to eat. You must eat for us, so eat good food. Remember azetidine. . . .)

A powerful, insistent odor penetrated her mind. Gradually she was roused to the outer world, where she saw and smelled a dish of figs. The figs were overripe, just like the ones her family used to serve in the old days, before they died one by one and her mother became Sarai. The dish was held by a small woman, a stranger dressed in a nondescript talar. 'jum was confused. A dish familiar enough to bring tears, held by such a strange woman.

"It's all right, dear," the woman spoke soothingly. "Tell her, Station."

"You may eat the food," Station's voice boomed. "You may address your visitor as Honorable Secretary,"

"Never mind, dear," said the stranger, "'Nana' will do. Go ahead, eat."

'jum was powerfully hungry, but she remembered what *1 0 0 3 7* desired. "Azetidine," she said. "I want azetidine and mimosin. And I need extra arsenic."

The secretary looked up.

Station said, "She can have those, they won't hurt her; she's been lifeshaped."

"Very well," said the secretary, "but eat this, too."

'jum took a bite, then quickly devoured the figs. The secretary sat before her, watching.

"Wasn't that good. Now, dear, what can you tell me about your little people inside?"

'jum thought. "We dance," she said. "We dance like this." She raised her arms to make a circle, then danced from one side of the room to the other, first three steps, then five, then seven.

The secretary watched respectfully. "How lovely. Can you tell me more?"

"We are the Dancing People. We dance all the numbers of the world."

"All of them?" echoed the strange woman. "Every single one?"

"It takes many generations."

"What if some day you need to . . . stop dancing the numbers?"

"That's easy. I just stop."

"And the people inside?"

"They understand. They do what I tell them."

"They always do as you say?"

"Of course they do. I feed them azetidine."

Through the next day, and the next, Verid alternately coaxed and interviewed the microscopic people, within the girl, and within the Spirit Caller, and within several other carriers as far as they could communicate. She worked without sleeping, trying as soon as possible to reach that magic point when she truly understood the micromen, or the 'Dancing People,' as 'jum called hers; knew them better, perhaps, even then they knew themselves.

Their habits, their foods, their children—to Verid, all seemed uncannily familiar. These were people, no question about it. Immigrants to new worlds, only they found their new world was much more than a mindless landscape. And each carrier carried a different breed developing a culture all its own, like a people after forty generations at a distant star. It stunned her imagination.

Still, there were troubling signs. Not all the "cultures"of the micromen were equally communicative. Not all had reached the stage of civility that would earn them entrance to the community of the Free Fold. And some of the human carriers had died before treatment could work. Most disquieting, two carriers survived but lost their minds. Physically intact, they moved and walked in silence, their brains submerged by some internal control.

To "cure" the incommunicative carriers, the medical sentients had injected nanoservos, by Khral's procedure that had cured Iras. But this time, it was too late. With the micromen removed, the

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former carriers lay in their beds, responding only to simple requests to sit up and eat. Their higher brain functions were dead. Was this the fate Rod had escaped?

"In the future, we'll prevent that," Khral promised. "We're developing nanoservos to confine the micromen to the occipital lobe, just where they grow to about a hundred thousand and send messages to the retina."

"So they can't spread and take over the brain."

"But carriers who volunteer could grow them to study. What an opportunity!"

Verid smiled. She did not tell her that the Fold Council cared little what some student in jeans could study. With one day left, none of the micromen could yet give her the one crucial thing she needed: a purpose compelling enough to convince the Fold to spare their planet.

Verid stopped by the room of Iras. "Dear Iras—are you well enough to go home?"

Iras reclined on a couch, her golden hair spread invitingly over the arm. She smiled, though her face was still pale as a ghost; appalling, after so many centuries of health. We are far from immortal, thought Verid sadly, though with just a touch of relief. "Well enough," said Iras, extending her arms. "And you, aren't you ready to leave this cursed place? You're not, I can see."

Verid sighed, enjoying the moment's rest in her arms. How easily she could have lost Iras forever. "Not quite. You know what the Council will do to this planet, and Station, too."

Iras shuddered. "Sorry for you, Station—but for the planet, I say, good riddance."

"For shame, Iras. The first truly independent mind humans have ever met—and we should destroy it?"

Iras gave her a look of sympathy. "You always did have a soft spot for plague-ridden planets."

"You made all your money off them."

"Not all—barely a fraction. I probably lost more than I made on L'li. And Prokaryon is a dead loss."

"It need not be. We've learned enough to control the micromen. We can choose, now, whether to carry them."

"Choose to carry them!" Iras shuddered again.

"The girl chooses to carry them. The young Spirit Caller chose, too, despite himself." But their reasons would not sway the Council.

Iras leaned over and brushed Verid's hair. "You know," she added reflectively, "I must admit the experience of illness has . . . given me a new outlook. I've had much time to think. I am truly sorry, dear, about your pet planet. If there were anything I could do, I would."

"You can. You can buy me time."

"How?"

"Buy off a couple of delegates—the Urulite, and possibly the L'liite, if you approach him right. Get them to postpone the hearing. Just buy me enough time to find something to convince them . . ."

To convince them the micromen were worth more to humans alive than dead.

Iras did not answer.

"I know you've taken heavy losses, dear," Verid told her. "But it shouldn't cost all that much."

"Except that someone got there first."

"What?"

"The neutrinogram came through this morning."

"What did it say?"

"Nibur already bought them off, to make sure the hearing goes forward. The vote is assured, no matter what we do."

Verid's hands turned to ice. She had been planning all week to postpone the hearing. "How could Nibur have moved so soon?

"He zipped home in Proteus three days ago."

"Yes. I should have known." Verid felt sick to her stomach.

"There are also reports of more carriers showing up, on Valedon and on Bronze Sky."

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Frightening, though inevitable. "The whirrs must have spread. Or the micromen have learned to transfer without whirrs." There was no help for it; Verid had to have the knowledge she needed now, before tomorrow morning when the express ship arrived to take her home.

Alone again on Station, Rod stared at the holostage, his throat tight and dry. He wanted to call in and see little Gaea, but he could not bear to face Brother Geode, let alone the Reverend Mother. They were sentients, he told himself. They had their own kind of love, but they were born in factories, made by machines. What could they know of the love of man and woman, the kind that betrayed the universal love of the Spirit.

HUMAN. HUMAN WORLD. Whenever he tried to think and concentrate, those bright letters were bound to pop up again. HUMAN, WE HAVE A QUESTION. IF SEVEN MEN ARE TRAPPED INSIDE A WHIRR FAR FROM HOME, WITH FOOD ONLY LEFT TO LAST AN HOUR, HOW DO THEY DECIDE WHO EATS? DO ALL EAT, OR SHOULD ONE EAT TO LIVE LONGEST?

Rod sighed, exasperated. "How should I know?" Since he returned their "brothers," this had been their game, asking him question after question as if he knew everything.

For a while the letters receded, then they returned. HUMAN. WHY ARE YOU SO INSCRUTABLE?

Suddenly it dawned on him. This was how the Spirit would feel, with people all over the universe sending out their petty prayers: Answer me this, give me that. What a tedious business it must be, to be a god.

"A visitor," called the room. "The Honorable Secretary."

Rod looked up eagerly as Verid came in. "It's working, just as you said. The microzoöids—I mean, the micromen seem to be behaving. They'll tell you whatever you want to know."

"Excellent." Verid sounded pleased, though very tired. Rod had never seen an Elysian look tired before. "So you feel comfortable, now, with your houseguests?"

"For now." He frowned. "But I fear they might change." What if they grew angry at their god? "When I sleep, I'm at their mercy."

"The new nanoservos will prevent that."

"That's a relief." He felt a flood of gratitude for Verid. "What a difference you've made, Honorable Secretary. If I have helped you in any way, it's been a privilege."

"Don't thank me yet," the secretary warned. "We have a long way to go—and little time."

"But you said Prokaryon is safe for now. And now, we can talk with the micromen, and control them—"

"'Now' was last week. Tomorrow the Fold meets—in secret—to decide the fate of your planet."

Rod was puzzled. "I thought so long as we could talk with them, you could work things out. Like with the sentients, the historic treaty, remember?"

"How well I remember," Verid sighed. "But this time, the Fold gave me seven days. Seven generations to save a world. On one condition." She leaned forward. "I have to find some utterly compelling reason why humans need the micromen—need them badly enough to risk their survival. Otherwise, their world will die."

He sat still, trying to absorb what he heard.

"You signed the release, did you not?" she reminded him.

"We all sign that, in case of a plague."

"Such as the plague of micromen."

"But they're intelligent!"

"True," said Verid calmly. "Nobody foresaw intelligent pathogens. And now the Council chooses not to see."

For some minutes he sat in shock, absorbing what he heard. Slowly he shook his head. "I'm not leaving." Let the octopods haul him away.

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"You won't. You're all carriers, or potential carriers." She paused. "I'm sorry," she said in a low voice. "I told you, I was the cupbearer for murderers. I couldn't tell you how badly things stood, because you needed to hope. You did well indeed, better than I could imagine. But it's not yet enough."

Rod shook violently all over. Then he found himself pounding the wall, his fists sinking deep into the nanoplast. *"No,"* he cried. "No, no."

"Be easy on Station. She, too, will die, in case they've infiltrated her nanoplast."

He stopped, breathing heavily. "Even the children?"

Verid said nothing.

HUMAN, WHAT IS WRONG? STRANGE MOLECULES IN YOUR CIRCULATION ENDANGER US.

For a while all he could hear was the pulse in his ears, and his sight blackened. Then his eyes cleared, and he looked at Verid again. "What shall I tell them?" he demanded. "What shall I tell the millions of people inside?"

"Tell them the truth."

He lay back on the bed and closed his eyes. *The humans,* he thought. *Other humans, from other stars. They plan to kill you—all of you, and your planet.*

For a long while there came no response. Then the letters slowly appeared. SO IT IS WITH US. OUR BROTHERS FROM OUR ANCESTRAL UNIVERSE PLAN TO DESTROY HUMANS.

"Destroy us?" he exclaimed. "Why?"

THEY SAY, INTELLIGENT WORLDS ARE TOO DANGEROUS. NOT WORTH THE RISK.

"That's true enough." Even travel to the stars was not worth the threat of extinction by such irrational carriers. "But you'll never kill us all."

NOT ALL. THE FEW LEFT WILL BE BRED AS ANIMALS.

Rod thought this over. "Perhaps it's not so bad, to be a llama. Perhaps it's what we humans deserve."

IT'S BAD FOR US. WE WILL PROTECT YOU, BUT OUR BROTHERS WILL KILL US TOO. FAR MORE OF US WILL DIE THAN YOU.

He laughed, a harsh laugh that caught in his throat. "They are just like us after all," he told Verid. "Brothers killing brothers."

But his own micros would die for him—so many of them, willing to give their lives for his sake. That was something to think about.

"They differ among themselves, just as we do. Aren't yours different?"

"They need me; I'm their home."

"If only we needed them the same." Verid whispered, her voice suddenly harsh. "That's what you have to find, Rod. Find what the micromen have that we cannot live without."

Left with this impossible task, Rod tried to question the micromen again, but he hardly knew where to begin. The micromen could not seem to grasp what he wanted, and his own mind wandered. What of his Spirit family; could they not yet escape in the lifeboats?

"Reverend Mother Artemis." The holostage announced. Rod shuddered; for this was the moment he had dreaded most. Yet now, staring death in the face, his own failings receded. "Reverend Mother . . . have you heard?"

"Of course, Brother Rod."

"Then can you do something?" He looked up eagerly. "You've always had connections. Can't you get out, with Geode and the children?"

The sentient did not answer. Her many breasts hung empty, and she had not brought the children. Rod's scalp prickled as he remembered; even the Secretary of the Fold could not save them. He looked away. "Forgive me, Mother."

"It is I who have failed. After all these years, I can see many things now, too clearly—but never mind. If the Spirit offers us one last day in this world, should we not spend it together?"

"What do you mean?"

Station explained, "I have lifted the

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quarantine. It seems . . . hardly useful, anymore, as we are all considered unclean."

"So, you can rejoin us now," said Mother Artemis. "Please, Rod—we need you back."

After weeks that had seemed like years, Rod was reunited with the family. For the children's quarters, Station had shaped one of her bleak corridors into a tall, arching vault, with the Prokaryan horizon lit by the spectrum of Iota Pavonis. Virtual wheelgrass swayed in a silent wind, and the brokenhearts hung ripe upon the fields. Rod felt pleased, then angry; was it crueler, he wondered, to prolong the illusion of home?

It was a burst of starshine to have the children climbing over him. T'kun clung to his neck, nearly smothering him, while Pima and Pomu clamored to show him their drawings on their lightpads.

"Brother Rod," piped Gaea, "when are we hunting zoöids again?" The Prokaryan sapphire danced eagerly beneath her chin.

There was 'jum at last, grown taller since she left for Sarai. The girl skipped over to see him; he knelt and caught her shoulders, meeting her dark eyes. "Are you all right, 'jum?"

"My name is one-oh-two-oh-oh-seven-one," she told him. "The Dancing People are going to dance to the stars." Then she skipped away again.

Geode wrapped all six arms around him. "Our prayers are answered—you're home again, Rod." As if that were all in the world that mattered.

Mother Artemis kept her distance, as if she somehow knew that he could not face her. Rod looked away. What did it matter, her thought; only another day more of this forsaken world. He whispered to Geode, "Do the children know?"

"Only Haemum and Chae." The two blue limbs entwined. "Mother Artemis let them return to Prokaryon."

"Welcome home, Rod," said the Reverend Mother at last. Her face that was not a face held a strange unrecognizable expression, and her snakes of hair twined tortuously. "I am ashamed to have done so little to protect our children."

"You did all that could be done."

"Why is the Spirit inscrutable? Yet, if it is written in the stars that our time has come to join *Architeuthis* in the deep, let us lift our arms in prayer."

That night the ceiling darkened, lit only with stars. Rod half expected the evening rain. The Spirit Callers led their evening prayers. Somehow Rod felt awkward wearing his old robe again, especially aboard Station. The children jostled and squirmed, worse than usual, with no room to run. 'jum could not stop herself dancing, weaving her strange patterns of the Dancing People, while the other little ones tried to follow her.

To Rod's surprise, they were joined by several human visitors, including Elk and Three Crows, and even Diorite. The miner shook his hand heartily. "Brother, I didn't expect to see you again. I said a few prayers for you."

"Thanks, friend." He sketched a star-sign for him. "I'm sorry you got caught here; I thought your crew got out."

Diorite shook his head. "I stayed on, to look after my investment. Truth to tell, I was betting on things turning out different—if they had, you see, those who stayed would make out big. But now—" He shrugged. "I guess we're all in the same boat with those L'liites, the ones that escaped down there. Still beats me we never found them, though we got close, I'm sure."

Rod swallowed hard. "I'm sure you did." He would never forget that ship crashing in the Prokaryan hills. But even if the passengers could have lived, the micromen would only have turned them into llamas.

There were two more visitors whom Rod did not know. Elk caught his arm and whispered. "They're 'carriers.'" Elk

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introduced them, one a starship attendant who knew Three Crows, the other a servo engineer from Valedon.

The servo engineer, a woman with blond curls, wore beads of opal and sardonyx. "You're from Sardis, too," Rod told her.

"The Sardish branch of the Hyalite House." She grinned at him. "A fellow exile, Brother."

Rod looked away. "I'm sorry you had to . . . share our fate."

She shuddered. "It was bad enough dealing with *them* inside. I feel like I died a dozen times."

"You said it," agreed the starship attendant. He leaned forward. "They say it's my yoga training that saved me. Is that true?"

"Same here," said the woman. "It's the one thing we have in common."

"Maybe." Rod was not inclined to speak of himself. "How are your . . . I mean, are you feeling okay?"

"Our little 'friends', you mean." The starship attendant laughed. "Mine are incurable tourists. They want to see holos of every nightclub on every planet. I could have taken them anywhere—and look where we got stuck. No offense," he added.

The engineer adjusted her beads. "Mine are chemists. They want to know what everything is made of—and tell me how to make it better. Just think what they could teach us about nanotech. We'd leap forward a hundred years."

Rod's heart skipped a beat. "Did you tell the secretary?"

"Yeah, I told her." Her face drew in, and her brows knotted. "Politicians," she spat at last. "They'll be the death of us."

"True, but . . ." The man studied the floor. "Remember, some carriers weren't so lucky. The ones who ended up, like, lobotomized—I'd rather die than be them."

"And how many others are out there?" she demanded. "You think *all* the carriers came back here? Some weren't so foolish as us."

Geode was rushing back and forth, his arms full with squirming toddlers. "They know something is up—they just won't keep still."

Mother Artemis spread her skirt, and the beautiful squid leaped out of the rolling sea. The children hushed and stared, their mouths half open. *On the first world of the first mothers and fathers, in the first ocean there ever was, the creature of ten fingers swam down to the dwelling place of the great Architeuthis. . . .*

Letters flashed before Rod's eyes; of all times, he told himself, much annoyed. WHY ARE YOU SAD? the micromen wanted to know.

"Because we're doomed," Rod whispered back.

NOT FOR A GENERATION OR MORE. A LOT CAN HAPPEN IN A GENERATION.

And the ten-fingered one said to the ten tentacles, "Of all things great and fearsome, the greatest and most fearsome of all is the human being. I alone sail the skies, and I sell the stars. My machines plow the earth and build jeweled dwellings taller than mountains. I conquer all knowledge, and my progeny people all the worlds."

SOMEDAY, WE TOO WILL PEOPLE ALL THE WORLDS. WE WILL RAISE A GREAT TEMPLE TO YOU, OUR GOD.

Rod could only shake his head.

"Of all things deep and dreadful," warned the long-dead Architeuthis, "the deepest and most dreaded am I. For I plumb the depths and devour the fallen. My tentacles consume whales and comb the abode of giant clams. I ruled the deep for eons before others crept upon land, and my being will outlast time."

At last all the children were in bed; it felt like old times, tucking them in. Rod tried to sleep, but he felt restless. He could not stop thinking of the one person who had not come: Khral. He knew why she had not come, and she was

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right. And yet—why should she be alone, on this of all nights? Of all of them, she had done her best to let Prokaryon live. And she had touched something in him; he could not deny that. Something in him had come alive in her arms, and now they had so little time.

In the darkness of early morning he got up, hurriedly pulling on the travel clothes that he usually wore on Station. A pale light appeared in the ceiling; he waved at it to go away. It grew dim, just enough to get by. Hurriedly he dressed and left the quarters of the Spirit Family.

He found Khral in the laboratory with Quark's eyespeaker perched on her shoulder, amongst the culture vessels and samplers. Sarai was there too, busily sealing up some kind of samples in little seed pods, her fingerwebs snapping as they flexed. Khral looked up from her data that streamed across the holostage, and she managed a smile. "It's you."

"For better or worse." He caught her hand and held it. Turning to Sarai, he added in her native tongue, "Share the day, Sister."

Sarai did not look up. "The day be cursed. I knew I should never have let that devil off my planet. Now it's too late, for us—but not for *them.*" She held one pod up to the light. "I've sealed up several packages of 'jum's sisterlings; dried out, they can last forever. I'll launch them, in the direction of the nearest planet-bearing stars. They'll land, someday. And they'll remember."

"Crazy Sharer," muttered Quark. "Do you think Station will let you launch them?"

Station did not answer. Rod wondered what the great sentient satellite thought of her own imminent demise. But he felt Khral's hand, his blood rushing in his ears.

Khral nodded at the holostage. "I keep trying." She sounded alert as ever, despite the sagging around her eyes, her face more gorilla-like than usual. "It's our last chance—may be anyone's last chance for a long time, to study them, to learn what they're about. Whatever data we find will outlast us."

"A career's worth of data," said Quark, "in the days we have left."

Rod watched them curiously. "Is it so important, your scientific data? Was it worth giving your lives for?"

There was silence. Khral said at last, "There must be something those micromen can do for us. We still have a chance to find it."

"Like what?" said Quark. "A better way to make azetidine? Face it—nobody cares. Look, Khral, I hate to point this out, but you're a human, and you're running down for lack of sleep. Leave me here to run down the last list."

With a nod, she took the eyespeaker and set it on the counter, then she and Rod left together. In the corridor, Khral pointed to a viewport. "Look, do you see that tiny starship? It's Sharers, come to witness. Their ship is very small, but they could take three of your children, if you put them out in a lifeboat."

Which three? he wondered bitterly.

They reached her room, and the door sealed behind them. They fell into each other's arms. This time they made love more slowly, exploring every inch of each other, for there was time, perhaps the last time ever. When at last they were satisfied, they lay together, half sleeping.

"It can't be," Khral whispered. "It can't be over, just when life got to be worth living." She raised herself on her elbow. "Rod . . . did you ask them? You're sure there's . . . nothing they can do? Microbes have always done for humans—leavened our bread, brewed our beer, made our vitamins."

He shook his head wearily. "They call me a god, and can't imagine what I would need from them."

"How odd. That's not how they talked in the beginning. They offered—"

"Never mind." Rod shuddered. "They evolved."

"They got too tame, that's what. All

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the ones in the carriers have been domesticated for generations. Could a dog tell why his master needs him?" She got up and reached for her clothes. "We need fresh ones, that's what. Station," she called, "tell Quark: We're going back to Prokaryon."

CHAPTER 23

Verid awoke early in the morning, her mind still running over the options. Never in all her centuries of public life had she found so few. After all the Elysian children she had raised, as director of the *shon*, now she had to leave children to their death. In any office she had ever held, as guardian of Helicon, as Prime Guardian, now as Secretary of the Fold—never had she left a world to its destruction.

"Station?"

"Yes, Secretary."

Beside her in bed, Iras still lay asleep, her hair flowing over the pillows, as beautiful as the first day they met, ten centuries before.

"Station, I'm sorry."

"It was my choice," Station assured her. "I took the risk from the start. All the colonists knew what they signed."

"Even the infants?"

"All the children admitted were on the verge of death when they came, death by disease or starvation. At least I will assure them a death without pain."

Barbarity, thought Verid. No matter how far we advance, always we revert to barbarity, in one civil guise or another.

Iras stirred and stretched, and her eyelids fluttered open.

Verid smiled for her. "Dear, are you well enough to leave?"

"The sooner the better. Is our ship here?"

Station said, "The ship is here. The ship awaits your call."

Verid slowly rose from bed, and very deliberately dressed and checked her clothes and nanoservos. All the while her mind was running full speed. What could she do? She could postpone the hearing, by a technical maneuver; but that would gain a day or two, and only earn her censure.

"The ship wishes to address you," reminded Station.

"Very well, put him through," she muttered.

The bridge of the ship appeared on the holostage. The ship, an outsized sentient like Station, introduced itself with all the usual formalities. "By the order of the Fold Council," the ship intoned, "I am hereby directed to secure your passage to Elysium. Be advised, Secretary, with all due respect, that full precautionary measures will be taken. You will wear a skinsuit and remain in quarantine until testing is complete. Be assured, nothing will hinder your official duties."

The secretary stiffened in every muscle. This was the final indignity—to return with the status of contamination. "I have been tested by every means possible. I have not the least sign of . . ."

Station concurred. "The person of the Secretary has been subjected to every possible test of microbial contamination, including nanoservo inspection, molecular scanning, and—"

"Excuse me, Station; just a minute." Her head was spinning. It had come to her at last, the one thing she had to try. "Station, there were those two confirmation tests—remember? You never did perform them."

Iras frowned. "You can't be—Verid, you didn't tell me."

"Station," Verid insisted, " You did not do those tests."

Station said, "As you say, Secretary. I regret the omission."

The ship replied, "An extremely serious error, Station. You were to have the secretary ready by oh-seven hours this morning."

"Indeed. I shall report myself to the authorities. I deeply regret the inconvenience, but the secretary will be delayed . . . some hours."

"Twenty-four hours," put in Verid.

"This is *most* regrettable. The Council

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will not be pleased." The ship signed off.

Iras caught her arms. "Oh, Verid—what are you doing? You've been through every test."

"Only rats leave a sinking ship."

"What good will another day do? You'll be impeached."

"So, I'll retire and you'll see more of me."

"Be serious! What's come over you?"

"I've never liked working through interpreters," Verid observed, "even the best of them." She held Iras close. "Iras, I can't explain now; but this is something I need to do. You will go home without me tomorrow."

"What?"

"Don't worry, the Council will do nothing until I return. Meanwhile, do your best to buy back whoever Nibur got to. The Urulite, at least; he'll be cheapest."

"Verid—you can't. You've never been sick, yourself; you can't imagine."

"And Station—if you value your life, activate your shield, and let no shuttle from that ship come to fetch me."

In the clinic Verid met with Khral, as three medical sentients hovered nearby.

"We must inform you,"said the senior medic, "that after due consideration, all three of us strenuously object and advise against the procedure."

"Of course you do," muttered Verid. "I'll sign whatever form you need. Let's get on with it."

"You must understand—we lack the knowledge to stabilize the Prokaryan pathogens within your Elysian physiology. Especially infections agents obtained de novo from the wild."

Verid turned to Khral. The student pressed her hands to her forehead and tried to speak, but coughed instead. "It's just an idea," Khral explained, her voice dull with fatigue. "I brought some whirrs back from the planet, where the micromen still know the full potential of their species. Within humans, I think the populations living their short lifetimes have forgotten a lot."

"I understand."

"I've put them together, temporarily, with a few volunteers from Rod, to teach them our language. Then one of the carriers may volunteer—"

"We have no more time for intermediaries. I will contact the micromen myself."

Khral's face turned gray. The medics reared back indignantly, as if washing their many limbs of it. Khral swallowed and said, "Remember, the injected micromen will be a very small population. They will want to reproduce right away; for a while, the proportion of elders will be small, and they'll barely have their 'children' under control. That is the dangerous period."

"We'll get through it. They'll learn to communicate?"

"They seem to learn different ways, depending on their host. With 'jum, they use their own number code, which works well for her. Rod's micromen, I hope, will teach yours letters you can read in your . . ."

"Yes, I know." Verid stretched out on the hospital bed, while Khral prepared the whirrs and the medics injected her with all kinds of protective nanoservos. She imagined the tiny machines coursing through her blood to check all her tissues and organs, preserving the proteins needed by every cell. What was harder to imagine was the microscopic living beings, setting down for the first time within a human world. For each of them, each with its own life, its memories and dreams—how would it feel?

The vial of whirrs pressed her skin. Like the virtual jellyfish that had touched her foot, when Nibur had laughed. But this time she did not flinch.

"It's done." Khral's voice was barely audible as she put the whirrs away.

So I'm a carrier, thought Verid. For a moment she was gripped by terror; she felt as if she were falling down a deep well, unable to stop herself. But it

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passed. She was still herself, after all. "It's done," she echoed. "What next?"

"You have to wait and see. We'll hope they make contact."

A half an hour passed, while Verid made the best of her time reviewing staff reports on the holostage. Then suddenly she felt hot all over, from her hands to her forehead. "What is it?" She breathed rapidly, thinking, they're burning me up inside.

The medic told her, "You're running a slight fever. It generally happens as the infectious agent settles in."

Fever. Verid had heard of fever, read about its sufferers, but never experienced it. "Are you sure it's all right? Even for an Elysian?"

"It's a low fever, so far. Even for an Elysian."

She repressed the conviction that she was boiling to death, and felt a bit ashamed. Living for centuries in their floating cities, Elysians knew so little of life.

The first spot of light flickered on her retina. Verid sat up straight.

"Rest yourself," insisted the medic. "So far, your nanoservos report, the infection is highly localized within your brain. But if it spreads, you'll need all your strength."

"Station, lights down," she ordered. The light dimmed, except for the holostage outputting her vital signs. She closed her eyes. Something flickered again. "Khral? Are you there?"

"Of course, Secretary."

"Fetch the other carriers here, too." She would need all the help she could get. The seconds and minutes passed, seeming endless; yet how much longer they must seem for the micromen, who lived ten thousand times faster? How would humans keep up talking with creatures who took a week to reply to the simplest question, and went to sleep for a decade?

GREETINGS, HUMAN WORLD. The letters appeared in her eyes, unbidden. She tried to tell herself, it was just like one's nanoservos talking after all. But this was different. These internal creatures had minds of their own.

YOU ARE NOT LIKE THE OTHERS.

She took a deep breath and tried to stay calm. Nearby stood the carriers, even 'jum in the corner with Rod. "How do I answer back?"

There was an awkward pause. Rod said, "It just happens, after a while."

"Try reading letters in the holostage," suggested the flight attendant. "That always worked for me."

Khral agreed. "The first thing the colonists learn is to read your retina."

"Indeed." 'Colonists'—a startling thought, but so they were. "Very well. Holostage, print these words: 'Who are you?'"

The letters appeared above the holostage, and Verid concentrated on them. Immediately came the reply: WE ARE THE PEOPLE. YOU ARE A WORLD TO BE MASTERED.

"That won't work. You will have to deal with us." The words floated in air, and she stared at them until her eyes swam.

SO SAY THE MESSENGERS. WHAT CAN YOU DO FOR US?

Verid looked up. "What can I do for them?"

The flight attendant laughed. "Travel—that's what they want."

"We can't." Not yet—but some day.

'jum raised her hand. "Azetidine. Give them that—it's their favorite."

The medic reared its caterpillar body. "Poison!"

"Azetidine is moderately toxic to your system," said Station. "I am preparing a sample, with protective agents." The wall nearby puckered to spit out an ampule, which Khral fitted to an injector. The injector painlessly dissolved a microscopic well into her vein, then sealed the opening on its way out.

YOU ARE LIKE THE OTHERS. LIKE YET UNLIKE.

What "others?" Verid wondered. Of course, the messengers came from Rod.

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YOU CAN GIVE US MANY THINGS FROM THE STARS, BUT YOUR BODY IS INCOMPATIBLE. IT WILL TAKE A GENERATION TO FIX YOU.

"That it would," Verid said aloud. "It would take decades to lifeshape me for Prokaryon. We don't have that kind of time, but—"

"No it won't," interrupted 'jum. "Lifeshaping doesn't take that long."

"Hush, 'jum," whispered Rod. "You're a child; adults take many years." And even then could not bear children.

The holostage announced, "Medical alert. Massive physiological changes occurring within patient, as microbes colonize circulatory system, liver, intestinal epithelium . . ."

"Station," called the medic, "the patient is suffering massive physiological effects. I demand an immediate halt to this ill-advised experimental procedure, or else I—I will seek termination of your license."

Station said, "The choice is yours, Secretary."

"What's going on? What are they doing?"

"I wish I knew. But they cannot destroy you without destroying themselves."

"That hasn't stopped humans," Verid dryly observed. "Holostage, spell out: What are you doing to my body?"

WE FIX YOU TO LIVE HERE. LIKE THOSE WHO FELL FROM STARS, BUT YOU ARE DIFFERENT.

"'Like those who fell from stars—' Who is that? And why am I different?" Verid was throughly confused, and the continued recitation from the holostage did not help.

Rod caught her arm. "The L'liites,"he exclaimed. "You're like them, but you're Elysian. The L'liite ship crashed, but some survived, and the tumblerounds found them."

"They could not have survived long."

The medic said, "The presence of the microbes is altering the patient's biochemistry by the minute. If this madness does not stop, I withdraw from the case."

"The L'liites did survive," Rod insisted. "Diorite tracked them. But—"

Verid's jaw fell open. "'A generation'—Holostage, print out: *'How long will it take to fix me? Whose generation?'*"

OUR GENERATION. BUT WE ARE PATIENT. MEANWHILE, PLEASE FEED US AZETIDINE, HYPOGLYCIN, AND MIMOSIN.

A generation of micromen. A single day. Verid tried to stand up, but her head swam with fever.

"Please, Secretary," cautioned Station. "Your body is reacting to massive changes in chemistry. Are you sure you will continue?"

"Yes, by Torr," she exclaimed weakly. "Don't you see? They can lifeshape us in a single day—anyone. At no cost." She raised her arm. "Find those L'liites."

On Prokaryon, the weather had taken a turn for the worse. All around the planet towered hurricanes whose lightning struck any vessel from the sky. From space, the planet's disk was a mass of tumbling clouds. Never before had the world been seen thus, not since the days of the early explorers.

"Somehow they know," Rod told Diorite, as he watched the holostage, clenching and unclenching his hands. "They know what the humans have in mind." Not that it would help against the white hole.

"How could they know?" demanded the miner. "Did the Spirit tell them?"

"Chae and Haemum were carriers. Their micromen must have told the others." He could imagine the light-coded messages leaping across the singing-trees where he and Khral used to collect their samples.

"By Torr—if *that's* it, can you imagine what's in store for Valedon once those critters multiply?" Diorite shook his head. "We're doomed, whether we save that cursed planet or not."

"The secretary doesn't think so. She thinks we can deal with them. And the

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L'liite survivors will convince the L'liite delegate to change his vote. That's why we have to find them."

"Oh really? What if we find them turned into llamas?"

He tensed all over, then relaxed. Sketching a starsign, he said a prayer.

Station announced, "The shuttle is ready, shield fully activated. All members of search party assemble for boarding."

The search party made a hair-raising descent, sustaining several strikes of lightning. When at last they landed, they struggled across the ground drenched by rain, stepping over carcasses of drowned four-eyes. Besides Rod and Diorite, six forensic sentients fanned across the hillside where months ago, Diorite's crew had last seen tracks. They stumbled and dug each other out of mud laced with treacherous loopleaves, then climbed over singing-tree trunks felled by the storm. The roar of the wind hammered Rod incessantly. "Tell them to stop," he urged his internal visitors. "Send whirrs to tell them—we mean to save their world, not destroy it."

OUR WHIRRS CANNOT SURVIVE THE STORM. WE REMEMBER OUR BROTHERS, BUT HAVE NOT SEEN THEM FOR COUNTLESS GENERATIONS. WHERE WOULD WE FIND THEM?

Out of the corner of his eye a light flashed. The thunderclap deafened him for some minutes. Diorite caught him with his arm and shook him, trying to say something.

"The sentients have found something," shouted Diorite. "A whiff of human flesh. But there's no sign of them."

How could there be any sign, Rod thought; any footprint would have been washed away. Bracing himself against the wind, he surveyed the drowned landscape. Hills rose above the valley, one of the wilder corners of Spirilla even in fair weather. Outcroppings of rock jutted exposed to the elements. There was something vaguely familiar about the character of the rock. He wiped his eyes and squinted. Fog was rolling in across the rocks, but just for a minute the clouds parted and the rock shone clear.

"Sarai's place," he murmured. "It's just like the road to Sarai; the same kind of rock formations. And Sarai used to live—" He grabbed Diorite's jacket. "Caverns," he shouted. "They could be hiding there."

"That's it! We have to scan the earth deeper." Diorite called into his radio, which somehow was still working.

Rod could not say how long it was until at last the forensic detectors had traced the human signal to one stretch of hillside. The searchers traced back and forth, but still nothing could be seen, no hint of any kind of entrance in the mud.

FORGIVENESS. EVEN IF A PLANET DIES, ONE MUST ALWAYS FORGIVE. THIS WE WILL TELL OUR BROTHERS.

His shoulders shook, and his tears joined the rain. These micromen had "evolved" too far, he thought; they made him feel small.

Suddenly the ground gave way beneath his feet. It was not ground after all, but a tangle of branch loops woven cleverly together. Now, though, it was falling apart. Rod struggled to right himself and climb out, but he slid inexorably into a dark hole.

An arm came round his chest, immobilizing him. At his neck pressed something sharp, the blade of a knife.

Rod made himself relax. Whoever it was had not killed him yet; his best chance now was to wait for an opening.

"Not one move, you devil." The voice spoke in L'liite.

"Kill him now," urged another. "Spirit save us—they won't send us back." They did not sound like "llamas." And yet—they were alive.

The rest of the opening crashed through. In the confusion, Rod slipped away from his captor and crawled across the floor. Light broke through, and there were screams and shouts. Rod heard a zapping sound that he did not recognize. Abruptly all was calm,

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except for the cursing of three L'liites immobilized by webbing emitted by the forensic sentients. Somewhere unseen a woman was sobbing.

"Spawn of dogs," cried one of the L'liites, straining at the nanoplastic web. "We'll die before you send us back."

"We won't," shouted Diorite. "We need your help to save our planet."

Not a likely story, Rod realized. How could the L'liites believe it? As Diorite tried to persuade them, Rod's eyes adjusted to the dim light. The cavern had been swept and kept tidy, until their rude entrance. There were pots and blankets and an oil lamp in the corner. The rubbery smell of cooked four-eyes was familiar. The woman sobbing in the corner held something protectively.

"Father," called one of the trapped men. He was calling to Rod, staring at his starstone. "Father, you will tell us. Is this true?"

Rod flushed, for he was only yet a Brother, and the stone felt heavy on his neck. "Yes," he replied, sketching a star. "It's true."

The woman looked up. "A Spirit Caller," she exclaimed. "At last—one to bless the new name." She held up a tightly wrapped infant, its eyes tight shut, sleeping through the storm as only infants could. Its face was still wrinkled like an old man; he or she could not be more than a month old. The first human baby born on Prokaryon.

Chapter 24

From within the Fold ship Verid watched the glittering sphere of the Secretariat, in its eternal orbit about Elysium. She flexed her fingers, uncomfortable in the skinsuit that the medical service had decreed she must wear—for the rest of her life, perhaps? Glacially she eyed the three octopods assigned to guard her—or the entire Fold from her.

In another ten minutes the shuttle would take her down, straight into the council meeting she had postponed for the past week.

THEY ARE TAKING NO CHANCES. NOT TO LET YOU CHANGE MINDS.

STILL, YOU COULD WORK ON THE BRONZE SKYAN DELEGATE. SHE LISTENS TO REASON.

THE SENTIENT DELEGATE COMMUNICATES ON OUR TIME SCALE. PERHAPS WE CAN REACH HER—

Verid blinked her eyes. "Enough already; I can't hear myself think." She had tried to educate her internal symbionts about Fold politics, and now they all wanted to advise her. Unlike her human advisors, she could not sack them.

On the holostage appeared the head of Delegate Elysium, stern but triumphant. "With all due respect, Secretary, the Council asks me to advise you that you are to join us *directly*, with no inappropriate word to the press. You understand my meaning. This is only a photo-op."

"Of course, shonsib." Her voice sounded hollow inside the skinsuit which covered her mouth. "Just a photo-op." Although the council meeting was closed, all kinds of frightful rumors had gotten out, and the Fold was in an uproar. The snake-eggs would demand a brief statement.

"I trust you've read and understand the charges against you."

"Absolutely. Second on our agenda."

WE'RE LOOKING FORWARD TO THIS MEETING. SOME OF US WILL LIVE TO SEE THE END.

YOU NEED TO VISIT OUR COUNCIL, TOO. PLEASE REMEMBER PROTOCOL IS MOST IMPORTANT. THE LESSER OFFICIALS FLASH BLUE AND GREEN, WHEREAS THE GREATER ONES FLASH PINK AND YELLOW.

"Secretary?" The welcome sound of her nanoservos in her ear.

"Finally," she exclaimed. "Is our plan ready?"

"Yes. We have all the snake-eggs expecting a statement, just ten minutes outside the meeting."

An aide approached, his Elysian train full of sky-blue butterflies. "Verid—it's a wonder to see you."

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Verid lifted her hand, feeling her "skin" stretch. "Wonders never cease. Tell me the worst, Lem."

"Elysium is nearly in panic. Everyone is getting 'tested,' although they scarcely know what they're testing for. And now they're expelling all foreigners—all but essential ones, of course . . . "

Verid swung round to meet him, her nanoplastic train swerving expertly, and the octopods fell in beside. Slowly the convoy progressed to the door of the shuttle craft. Elysians took their time.

". . . Valedon is near as bad; there are riots in the streets of Iridis," continued Lem at her ear.

WHAT SORT OF HUMAN IS THIS? A GOOD WORLD TO VISIT?

No. She strove to burn the words into her retina. *No, I say; be still.*

BRING US WHIRRS. WE CAN PENETRATE YOUR "SKINSUIT."

Verid squeezed her eyes. *Stay put, lest you and I be incinerated.*

"Secretary?" Beside her Lem was frowning.

"Fatigue, that's all. Do go on."

The shuttle craft docked, its nanoplast melding into the surface of the Secretariat. In the wall a mouth opened to let Verid pass.

"Secretary," whispered the nanoservos in her head. "Now is the time."

The snake-eggs jostled so thickly that Verid instinctively raised an arm. Octopods waved at them threateningly, but all knew that interference with reporters could bring a life sentence. Speech was the most sacred commodity of the Fold—and the most profane, she thought. The Council meeting was just minutes away; the nanoservos ticked the time.

"Secretary, is it true that alien microbes will enslave us all?"

"Were you infected, Secretary? When will the test results be released?"

"What will the Council do?"

Verid shook her head. "Listen." She raised her voice and spoke slowly. "I have one announcement to make. I hereby announce . . . by executive order . . . that the Council meeting about to begin . . . is open to the public."

The reporters fell back in confusion, the smarter ones zipping out to race to the Council chamber before the delegates could countermand Verid's order. As she entered the chamber, they were indeed attempting to do just that. But it was too late, Verid saw; some of the reporters had slipped in, and to eject them would make a scene nobody wished to be seen in.

"Never mind." The Delegate Bronze Sky glared, her dark features rigid with fury. "Verid, I've backed you before, but this is it. You've a lot of explaining to do."

"And one more count of impeachment," observed Delegate Elysium, reclining comfortably in the seat that opened beneath him like a flower.

"Oh hush," said Delegate Sharer. "Let's at least congratulate the secretary on her return alive and well." The Sharer was purple as always, with the oxygen-breathing microbes that thronged in her flesh. Verid smiled gratefully, thinking, we are sisters now.

Delegate L'li watched intently. "Congratulations, indeed." He had received her secret message—but had sent no reply. Still guarding his options.

"We waste time!" Delegate Urulan shook his fist at her, playing to his own home audience. "Boil the planet! Better yet, eject it to another universe!"

Verid kept standing. "It is my duty as Secretary of the Fold, and my great honor, to certify the discovery of a new, intelligent community of people. A new form of intelligence, indeed the first form we've met that evolved completely outside human civilization." She leaned forward. "Microscopic people."

"An outrage!" Delegate Urulan was beside himself.

"Out of order," snapped Delegate L'li. "Let the secretary continue."

Verid went on. "These microscopic people live a year for every ten minutes

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of our own lives. Their species and culture evolved at a comparably high rate. A hundred years ago, when our first human explorers arrived on Prokaryon, they had only just diverged from the lesser microbes whose ancestry they share, like our own stone-age ancestors once did. Even then, they covered the entire planet with rows of crops they tilled and the animal hosts they governed. Today, they run advanced communications all across their planet—advanced enough to rule their planet's weather at a moment's notice. This is indeed an intelligence worthy of our respect."

"Finding intelligence was not your charge." The Delegate Valedon's jewels glittered on his talar. "Your charge was . . ." He stopped, eyeing the reporters. Genocide was not done in public.

"But more than our respect, these people—we call them 'micromen'—bring us enormous hope. Living within our bodies, they can be partners to us, in a grand new venture to the stars. They can use their own chemistry to extend our physiological capacities to inhabit new worlds. Not only Prokaryon, *but other new worlds.* No more laborious lifeshaping; no more costly colonies that never pay back. As proof—"

She tossed a lump of nanoplast to the holostage. The stage filled with the L'liite refugees, presumed dead yet found alive and well, in a habitat that should have killed them in a week. The three men and a woman stared defiantly. The woman clutched her infant with one hand, and the other raised her fist. "This is *our* world. Long live New Reyo!"

Verid carefully avoided looking at the Delegate L'li. For a moment she regretted the future she foresaw—a thousand worlds overrun by humans with their micromen. But that was a problem for another day. "The child you see was born to these healthy, untreated immigrants—*born on Prokaryon*, a feat that none of our lifeshaping has yet accomplished. Their microbial symbionts figured out how to do this. Citizens, try to imagine the intellect that achieved this. Humans and micromen—What miracles can we not accomplish together?" She scanned the reporters bobbing up and down beneath the ceiling.

"Honorable Secretary," the Delegate Elysium smoothly began. "Surely you are not taken in by this . . . constructed footage."

"I shook their hands myself."

Delegate Elysium shuddered delicately; Elysians never made physical contact in public, let alone with carriers of a plague. He shook his head with elaborate condescension. "Really, shonsib. We know you've put your heart into this, but the job of the Council is to be objective. Do you agree, Delegate Valedon?"

Delegate Valedon was busy whispering to his nanoservos. He looked up to say, "My confidential sources assure me the scene cannot be genuine. How were these purported L'liites 'discovered' just now, so conveniently?"

Verid raised her eyebrows. "Do you question my integrity, or my competence?"

"Come, Citizens," demanded Delegate Bronze Sky. "You can't fool the reporters. We know it's true: The L'liites were found alive. The question is, what to do about it?"

"No, Citizens." A new voice came from the holostage. "That is not the question."

It was Nibur Letheshon. Nibur stood in their midst, his virtual talar shimmering before the neverending wave of *Proteus.*

"What's this?" exclaimed Verid. "Out of order."

WATCH OUT, PLEASE. YOUR ADRENALINE RUNS TOO FAST—IT MAKES US SICK. Verid closed her eyes.

Nibur was saying, "You yourself opened the Council to the public."

"I called this witness," said Delegate Valedon. "Let him speak."

The others assented. Verid's thoughts whirled, trying to recalculate.

"Thank you, Honorable Council,"

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said Nibur. "The real question is, what about the carriers not so lucky as myself? What of those who died—or worse." His image was replaced by that of a patient in bed at Station, with a medical caterpillar bending over him. One of the two former carriers who had failed to heal.

The patient sat against the pillows. He breathed well, and his color looked good, but his eyes held a vacant stare.

"Stand up, please," said the medic.

The patient rose without looking up, the covers falling to his side.

"Now walk to the door, and come back."

This, too, the patient managed, putting one foot in front of the other. At the door he turned, then walked back to stand by the bed.

"Now tell us your name."

The man continued to stare. The entire Council chamber fell silent.

WHAT IS WRONG? THE CHEMICALS IN YOUR BLOODSTREAM FRIGHTEN OUR CHILDREN.

Verid tried to relax. *You know what your brothers and sisters have done, to other human worlds. Be still and let me think.*

"You see?" The medic inclined its caterpillar body toward the viewers. "This patient has entirely lost his higher mental functions. Before we cleared the infection, his empty mind was ruled by the so-called micromen. A beast of burden." The caterpillar bobbed its head. "I myself am a sentient, immune to infection so far. But you humans—this is what will become of you."

"What do you recommend?" called Delegate Valedon.

"What do you think?" demanded Nibur. "Even the so-called micromen confess that they plan our destruction. All the medics recommend prompt elimination of their source."

"Then you'll have to cleanse every planet of the Fold." Verid looked around the Council. "Those two unfortunate citizens received treatment too late—because they came from Valedon, and from Bronze Sky. Where have no micromen reached? One way or another, we have to live with them."

"They haven't yet reached us," said Delegate Solaris, from the most distant of the Fold's worlds. "Cleanse their main source. It may be too late, but it's the least we can do."

Verid felt a chill. She had counted on Solaris.

"Boil the planet," agreed Delegate Urulan. "We should have done so to start."

The Delegate Sentient added, "Alas, I have come to share the view of my medical colleagues. As much as I value the possibility of sentient life, I cannot but recall that the very first casualties of Prokaryon were sentients. Of course, we've adjusted our composition since—but what if these dangerous pathogens mutate?"

The second vote Verid had counted on, from one who ought to understand best. She turned to the lamp-post sentient, inwardly bitter. "What then?" she asked, her brows high. "Genocide? For a race newly certified? Do you propose to rewrite the constitution?"

The reporters bobbed expectantly.

"Cowards!" The Sharer snapped her purple fingerwebs. "My people have shared microbial symbionts for countless generations. How can you miss this opportunity?"

"The 'opportunity' is voluntary," Verid added. "Future colonists can choose to be carriers. The rest of us are largely safe, since transmission requires an insect vector. Control of the insects will contain their spread."

"For how long?" countered Nibur. "A good reason to wipe out the main source now, while they can still be contained. Intelligent invaders—who knows what tortures they'll invent?"

"I call for a vote," said Delegate Bronze Sky suddenly. "The white hole is ready and waiting—we need to decide."

"Second," called Delegate Valedon.

Verid's hands shook. "The question is

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called: Do we activate the white hole to cleanse Prokaryon?" She called the roll. "Delegate Bronze Sky?"

"No."One switched—she had a chance.

"Delegate Elysium?"

"Yes."

"Delegate L'li?"

The man paused thoughtfully. "For the moment I pass." L'li never liked to be taken for granted.

"Delegate Sentient?"

"Yes."

"Delegate Sharer?"

"No. My sisters will surround that world with a living shield."

"Order, please. Delegate Solaris?"

"Yes."

"Delegate Valedon?"

"Yes."

Verid turned to L'li. "Is the Delegate ready to vote?"

"I vote against." He rose to speak. "The decision is too sudden. We need time to study the possible opportunities for my people; indeed, for all the citizens of the Fold."

She swallowed, her mouth suddenly dry. "Delegate Urulan?"

"Against—*until we can completely wipe out this plague!*"

Iras had bought him after all; how many water projects, Verid could only guess. She collapsed in her seat, her own whispered vote nearly lost in the buzzing of reporters.

"Be warned," cried Nibur from the holostage. "You'll live to regret this day. You'll all end up mindless beasts."

Delegate Elysium raised his voice. "The Council is not yet done. The second item on our agenda is our call to impeach the Secretary of the Fold. I have been asked to read the charges—"

"Never mind," interrupted Verid.

The Elysian looked up, surprised by the breach of order.

"I resign, effective immediately."

Around the chamber, the delegates turned to stare.

"Impossible," exclaimed the Sharer.

"You'll beat the charges, Secretary. You have to fight."

"Sorry, but I meant it. I resign."

No one else spoke, but their faces all registered surprise and discomfort. They could not believe it, Verid realized. After five centuries of her rising in power, they assumed she would always have a win up her sleeve.

"You made this mess," accused Delegate Elysium. "How—how dare you just walk out of it!"

Verid sighed. "I'll stick around to help, if the Council wishes. But as secretary I cannot continue. It's too distracting, being a carrier."

The delegates gasped, and the reporters bobbed in confusion. Delegate Sharer came over to embrace Verid in her skinsuit, while Delegate Elysium turned pale and collapsed. There were calls for quarantine, and the octopods closed in.

WHAT IS GOING ON?

We've won your planet a reprieve. But you'll wait many generations before they set me free.

At Station, travel was reopened, though departure required extensive testing. Rod resumed something of his former schedule with the children on the satellite. With no farm chores to take his time, he immersed himself in their education, setting up regular programs for each child.

On Prokaryon, the storms had subsided within a few days. The micromen living there lost interest in the threat after two or three generations. Meanwhile, several mining firms sued to return, including Diorite, who had set himself up independent.

"It's the chance of a lifetime," Diorite told Rod. "Get in on the ground floor, before everyone figures it out."

"Really?" asked Rod. "Do people really want to live here and be carriers?"

"The smart ones are lining up to stake their claim. And not just from L'li either."

"But the Council could change their mind. Nibur still owns the planet."

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Diorite chuckled. "Rumor has it Nibur sold off his holdings at a sizable profit."

Rod was uneasy. "I don't know. Those micromen—I still think we're sitting on a time bomb."

"Not so long as they need whirrs to transmit."

"But they're intelligent. They'll learn."

Diorite shrugged. "They can't be more dangerous than a few humans I know—or sentients, they're no better. Say, when are *you* coming back? Feldspar's waiting."

"The Reverend Mother will decide."

Rod no longer ignored the news as he used to. He made himself spend a half hour at the holo each day. The Secretariat was at a standstill, with its former executive in quarantine, and special elections called. The worlds of the Fold hurled charges and countercharges of "who lost Prokaryon," though they all meant different things. Some cautiously welcomed the microbial symbionts, while others called for their destruction. New carriers of micromen appeared on Valedon. Meanwhile on L'li, Reyo was falling apart worse than ever, its streets split by roaming gangs, while thousands died of creeping.

One day Mother Artemis summoned Rod and Geode together. "Station says we may leave," she announced. "We may leave Prokaryon, after extensive testing; the children can join a Spirit Home on Valedon." She paused to let her meaning sink in. "Or, we can return to this world and rebuild our colony."

Geode's six arms waved at once. "Yes! Tomorrow."

Mother Artemis picked up Qumum, who crawled inquisitively across the floor. "Remember," she warned, bouncing the child, "the humans inevitably will be carriers, including the youngest children. What that may mean in the long run, we can't say." She and Geode both looked at Rod.

Qumum was sucking on his fingers while taking in the world with his wide eyes. Rod's internal guests had warned what the Prokaryan micromen might do to humans who returned. But he also remembered the L'liite newborn. "Better pioneers than orphans," he observed at last. "If the Spirit calls, let us go."

"So be it," said Mother Artemis. "We still need more help, though, to maintain the colony while we keep up the children's studies. Three Crows would like to stay on with us."

"I knew he would!" said Geode. "The Spirit heard our prayer."

Rod looked away, wondering what Elk would think. Then he thought of Khral. Since the crisis passed, he had avoided her, cursing his weakness. A Spirit Caller had no use for mortal love. Now that the colony had a second chance, so did he.

The light of Iota Pavonis filled the fields, already full of fragrant loopleaves. The home of the Spirit Colony had been flattened by the storm, and their crops mostly washed away, but the brokenhearts had reseeded and grown wild, filling the paths they had cleared with succulent golden rings. With Feldspar's help they began to rebuild their home, plow the fields, and restore the sapphire mine. Haemum and Chae returned to pitch in. They hunted down a herd of four-eyes zigzagging across the loop-leaves, and soon brought home fresh meat.

As Rod climbed to the roof to set new tiles, the breeze caught his cheeks and brilliant helicoids whirled overhead. His own spirit rose with them. Never had this world seemed so precious as since it nearly perished.

Yet in fact, the old world had perished; the old, mysterious world that Rod once knew. In place of mystery, there was the known, inescapable presence of the micromen.

HUMAN, THERE ARE SO MANY OTHER WORLDS OUT HERE. WORLDS EVEN OUR ELDERS BARELY REMEMBER, FULL OF BRAVE NEW PEOPLE.

Rod watched a whirr alight on his arm and take off, perhaps bound for a

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tumbleround at the edge of the singing-trees. It felt odd to be a city and airport for millions of microscopic people.

THEIR PEOPLE ARE DIFFERENT FROM US. So the micromen themselves faced culture shock. THEY FRIGHTEN US. THEY THREATEN TO TAKE US OVER AND RULE YOU LIKE A TUMBLEROUND.

Don't let them, Rod warned, setting a tile in place. Why had the Fold forced the former secretary into quarantine, instead of sending her back here to deal with these new "worlds"? For now, he could only hope Station's nanoservos protected him from any evil turn they might take.

TELL US SOMETHING. DO HUMAN WORLDS MEET AND MARRY LIFE-LONG PARTNERS, OR DO THEY COUPLE HEEDLESSLY, LIKE THE TUMBLEROUNDS?

Rod wished they would leave such topics until he was safe on the ground. *Both, or neither*, he told them. Some of us marry the Spirit.

WE NEED A LIFETIME TO KNOW EACH OTHER, BEFORE WE CAN SAFELY MERGE AND BECOME CHILDREN.

How odd, to grow up to be children.

On the ground below, Gaea came toward the ladder, her feet dragging dejectedly. "Brother Rod?"

Rod quickly came down the ladder and swung the three-year-old up to face him. "What's the matter, Gaea?"

"My head hurts. And I see funny lights in my eyes."

He frowned. In the younger children, the nanoservos were supposed to keep down the numbers of micromen so they avoided making "contact" until the children were old enough to understand. He took her to the holostage, which had just got reinstalled.

"Sarai, please."

Sarai had returned to her laboratory in the mountain, which had escaped the storms largely untouched. 'jum had returned with her to continue studying the micromen. Now they both appeared on the holostage.

"We're terribly busy right now," Sarai told him. "Two Sharer sisters have arrived to join my work on triplex DNA replication, and neither of them knows the first thing. They can't even run the enzyme secretors."

'jum looked up from her numbers. "I'll show them how." She had grown dramatically, her legs strong and slender; she would soon reach his shoulder.

Rod held Gaea up to see her. "You once cleared Gaea of microbes. Could you help her again? She gets headaches, and really feels bad."

Sarai looked shocked. "What do you take me for? I've renounced genocide. How could you live with yourself, cleric, let alone with all your internal friends?"

"They could always find a tumbleround." He had expected her reply, but it was worth a try before calling Station.

Suddenly 'jum leaned into the holostage. "Brother Rod, when are you coming to see me again? I'll show you my numbers, and a new dance I learned."

"Yes, when are you coming?" said Sarai. "We need to interview your sisterlings."

Rod smiled. "I'll come soon, 'jum; as soon as the crops are planted."

He closed the connection, dreading the call he would have to make to Station. The medics would help, but they always made him feel like a beggar. No one had heard from Patella for months now, and the Spirit Fathers showed no sign of sending another doctor.

"You have a neutrinogram," announced the holostage before he could speak. "From Chrysoport, Valedon: Brother Chrysoprase and Sister Heather, of the Sacred Society of Spirit Brethren."

The grainy monochrome image took shape. A man and a woman stood there, each wearing the same white hooded robe as a Spirit Caller, but with ropes of flowers around their necks and open-toed sandals on their feet. Much to Rod's irritation, they both sketched a starsign.

"Greetings," said Sister Heather, "from the Sacred Society, a sister order to your own. The Great Spirit of the Universe

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moves us to entreat you to accept our application to serve your colony. Our mission is to serve children, and where better than Prokaryon?"

"We are prepared to 'carry' micromen," added Brother Chrysoprase. "We've carried breathmicrobes for years, to help us dive and fish to support our order." Their skin was dusky, though the neutrinogram did not show the color. "But our numbers have grown, and you need us more."

"We bring many skills to help you," the woman added. "We've experience in farming, servo mechanics, child psychology. . . ."

This was but the latest request the colony's new found notoriety had brought them, from would-be colonists who had no idea what they were getting into. As for the so-called "Spirit Brethren," their help was the last thing respectable Spirit Callers needed.

"Enough," Rod told the holostage. "Keep the image in memory, for Mother Artemis." She would send the callers a polite reply.

Finally he gave up and took Gaea back up to Station. The old lightcraft had been fixed with a new controller, which kept it in good repair although it increased the chance that the craft would turn sentient.

At the clinic, the little girl shrank from the giant caterpillar, but Rod held her close, pressing her curls of hair. "It's all right. The doctor will help you feel better."

"We'll give her new nanoservos," the medic told him. "We've enhanced their program, to provide much better control. They adjust the level of certain key nutrients in her circulation, nutrients she doesn't need much, but the micromen do. And we'll keep working on it. Lots of volunteers want to get rich on Prokaryon."

"Even with all the hostile 'natives'?"

"Every frontier has hostile natives. It goes with the territory."

Rod looked closely at the sentient. "Are you new here?"

"Most of the old medics rotated out. I've come from the Brain Institute. What an opportunity—that is, to keep you healthy, of course."

In fact, Station's corridors were full of strangers. As Rod brought Gaea back to the lightcraft, they ran into a group on some kind of tour. Some were humans in faded jeans, others were sentients of various sizes and shapes; a "lamppost," a caterpillar, an eyespeaker for some nonmotile structure. The humans spoke in obscure jargon, oblivious to their surroundings, and even the sentients looked as if they had not checked a mirror lately. Leading the group were Elk and Khral.

"Rod!" boomed Elk's voice. "You should have told us you were back." He took two strides and gave Rod a bear hug.

"Glad you're here," said Quark from someone's shoulder. "Meet the new students."

From the front of the group Khral turned, but kept her distance.

Elk laughed. "We can always use another student, Rod. After all, your colony got Three Crows; I thought he'd never give up deep space. Why don't you join us?" Elk nudged his arm and nodded at Khral. "Ask our new Research Director."

"Bother about that." Khral waved her hand. "Good to see you, Rod."

". . . just when life got to be worth living."

Elk began introducing the new students, but Rod barely heard. Thankfully Gaea was getting restless, and he excused himself to take her home.

"Hope you had a nice trip," said the lightcraft politely.

Rod barely heard or knew where he was. He could only see Khral's look as she turned to him, and hear her voice call his name.

Geode came running out of their new home, its shiny roof tiles gleaming in the sun. "Rod—you'll never guess! *Patella is coming back!*"

It took a few seconds for Rod to real-

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ize what he had said. "Patella's coming back? To us? You're sure?"

Geode was hopping up and down on all six limbs, his starstone dancing crazily around his eyestalks. "Yes he is! He sent a neutrinogram. It took months and months, but they gradually got his mind working in his new body, and he's coming back." Rod had never seen him so excited. But then, Patella was like a twin to Geode, from the same Valan factory. They had always been especially close.

During worship that evening, as the new llamas groaned in the dusk and the gentle rains hid the moon, the Spirit Callers gave special prayers of thanks for their brother's imminent return. Rod tried to feel glad, but any joy he could feel was overwhelmed by the pain within. All he could see was Khral's face before him, and feel her in his arms again. He longed for her, yet hated himself. He was living a lie; he could no longer call the Spirit.

HUMAN WORLD—TELL US SOMETHING, WE PRAY YOU. The micromen would not leave him alone. IF ONE SOUL MARRIES ANOTHER, BUT THE MATE DIES BEFORE MERGING; THEN HE TAKES A SECOND MATE, WHO ALSO DIES; THEN HE MARRIES A THIRD; TO WHOM IS HE MARRIED WHEN ALL HAVE ASCENDED TO HEAVEN?

Rod closed his eyes. Make me a llama, he told them, like you tried to before. Then I'll no longer need to think or feel.

Early in the morning, Rod went to the Reverend Mother. The first rays of light from the window cast bright squares across the wall, and Rod blinked as they caught his eye. Mother Artemis was nursing T'kela. Her strands of hair stretched up toward him. "Rod, whatever is wrong, let me help you."

"I must leave the order. I've broken my vows, and I can't stay." He paused, then added, "I'm sorry to leave you shorthanded, but now at least Patella will be back. . . ." He stopped, full of shame and confusion.

"I'm so sorry. What a terrible time you must have gone through." She set down T'kela, who crept off to grasp at a sunbeam. "Will you join Khral?"

He shuddered to realize she had known all along. For some minutes he could not speak. "I can't," he said at last. "I care for her, but I would hate her for what I've lost."

"Then where does the Spirit lead?"

"The Spirit doesn't lead me any more. I suppose I'll join Diorite's crew for a while."

Beyond that, his future was blank. He had never before faced a future alone, without someone leading him on.

"Well, you can apply to the Most Reverend Father for release from your vows. It will take some months to approve and process—"

"No," said Rod sharply. "I can't stay. It would set a bad example for the children."

Mother Artemis paused. "The children will miss you."

"I will miss them." He choked on his words. "I can't imagine life without them."

"Is that all you'll miss, Rod? The children?"

"No, of course, I'll miss you, and Brother Geode. And—" He could not say it. "I still don't understand. I still feel the Spirit led me to Khral, as it did to the tumbleround. Yet it can't be."

"The Spirit tests us with choice. Sometimes one must give up a great love for a higher one."

"I did that, once," said Rod. "I gave up the Guard—my pledge of honor to Valedon. But now, I have to give up the Spirit."

"The highest love is truth."

To that he had nothing to say. Truth brought peace, if nothing else.

Mother Artemis was silent for a while. She looked out the window, her hair twining in the sunlight as if to soak up wisdom. "In truth, I have listened for many decades, yet I never understood why the Spirit would be jealous of hu-

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man love. Would you be jealous of your micromen?"

Rod blinked in surprise. "What are you saying? Do you question the vow?"

"The vow is right for some. It was right for you, for a time. I wish the Spirit Fathers would keep their other vows, such as to support this colony."

He could only stare, speechless at this heresy.

"I've been thinking, Rod. It's time our colony became more ecumenical. So many kinds of people want to help out, and we'll need their help, even with Patella back. I'd like us to accept those two Spirit Brethren who applied to join."

"The Spirit Brethren? But—but they're not . . . respectable."

"Respectability counts for little out here." The sentient's features made an odd slant, as if she were angry. "In truth, the Spirit Brethren are respectable enough. They split off from us several decades back, when two Spirit Fathers quarreled over doctrine. They hold the Sharer view that the Spirit calls each of us to conceive and raise our own child."

Imprisoned deep within an Elysian hospital, Verid paced the spotless floor, restless as a dog. There was company enough, the micromen within, and virtual visitors without; but for weeks now, no living human had so much as shared her breath. When would the Fold Council relent? The quarantine went beyond all reason, but, having stripped her of power, her opponents could enjoy their revenge.

IF WE EVER DO RETURN TO MYTHICAL PROKARYON AND DISCOVER NEW WORLDS, THEY WILL HAVE TO MEET OUR STANDARD OF CIVILIZATION. THEIR AMBASSADORS WILL HAVE TO LEARN OUR PROTOCOLS, FLASHING COLORS IN PROPER ORDER.

Verid sighed. By the time she ever got back to Prokaryon, her own micromen would be useless, having dwelt alone for generations. Precious time was wasting, while the timeless Elysians figured out what to do with her.

"A visitor," intoned the hospital. "Iras Letheshon."

Her head shot up, and she straightened herself. A cloud of light shimmered and became Iras, her hair flowing gloriously down her the back of her best train, the butterflies with their eyespots glowing red and gold. "Dear Iras," she breathed.

Iras smiled sadly. "I wish I were real, dear, but this is the best they'd allow."

"It's good of you to come."

"How can I be without you? Even if you are always muttering to your nanoservos. You know, Verid, I tried my best to spring you, but these medics are just incorruptible."

Despite herself Verid smiled. "That's good to know."

"Have you heard about Nibur? He was so besotted with that dog, he couldn't bear to lose it. You'd think he'd just make a virtual one. Instead, he had the medics cleanse his memories." Iras shook her head. "Start down that path, and it's hard to stop. He's not half the man he was."

Verid nodded. "Too bad."

"But look," said Iras brightly. "I've brought you something to keep you company—Raincloud's descendent!"

In a moment, there stood Sarai, resplendent in Sharer purple, flashing her fingerwebs as she lectured an unseen audience on DNA recombination. "Her research seminar, the one she gave at Station. It's on public record, so I acquired it. Isn't she gorgeous?

"Stunning," Verid laughed, "and most informative!" Then she grew serious again. "Listen, Iras; I need to tell you something. I give you my release."

"What do you mean?"

"I mean that I release you from our bond. You understand."

"But Verid—"

"Iras, think." Verid took a breath. This was hard, even harder than she imagined. "I carry micromen, now; I always will."

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"The Fold will let you out, eventually. They're just punishing you for being right. They need you to negotiate; why only yesterday Loris was saying—"

"But Iras—*they made you sick.* Remember?"

Iras shuddered. "Too well."

"You can't touch me again. No one in their right mind would. You can't take the risk."

She thought this over. "Dear, I've never been the one to worry about risks."

Verid looked down, feeling shamed.

"Besides—what a thing to say, after the fortune I just spent on you." Iras's net worth had fallen recently, by over three trillion credits.

"I'm sorry, the Urulite vote cost more than I thought." A lot more; enough water projects, she figured, to turn his planet into Shora.

"The Urulite? That was nothing. I meant your birthday present. Remember?"

Verid put up her hands. "Goodness; I forgot." What costly embarrassment could it be this time, for all the Elysians to cluck about? "Iras, I hope you were . . ."

"Discreet?" Iras finished. "You really are out of it, aren't you? Don't you even watch the news?"

"It's all censored here," snapped Verid. She nodded to the ceiling. "Go ahead, show it."

The Anaean newscaster appeared, his train of dead-leaf butterflies flowing behind him, similar to Verid's own. ". . . from Reyo City, the Health Ministry announces a new project to diagnose and treat the 'creeping' disease, and to undertake preventive measures designed to eradicate the deadly prions. Funded by an anonymous grant of three trillion credits, the project will establish clinics all around the planet. Within ten years, experts estimate, the prion plague can be effectively eliminated . . ."

Verid rarely flushed but she did so now, her face and hands warm, then cold. "Iras, you didn't," she said unsteadily.

"I would have named it for you, but you always said to be . . . discreet." Iras wiped tears from her eyes, then collected herself. "Plagues are bad for business, don't you know. And the one that's left won't be so easy." She walked forward, until her shape nearly touched Verid in the face. "Please, Verid. Don't be proud; tell Loris what he wants to hear, and get yourself out of there. I need you—and the Fold needs you, to talk with those micromen before they lose the chance."

Rod watched the sky for the old servo lightcraft he had sent up to Station. There it was, a bright oval descending toward the overgrown brokenhearts. Estimating where the craft would land, he jogged alone down the newly cut path. A flock of helicoids took off from the field, their propellers clacking, while in the distance the blue-striped four-eyes grazed unconcerned. Sometime he would have to chase the herd farther from their crops, but not today.

With a bright flash and a whiff of ionization, the craft landed and was still. Out stepped Khral, waiting, the wind lifting her hair.

Rod ran to meet her, too fast, as his feet stumbled through the loopleaves. He caught her in his arms and met her lips. Then they sank down together and lay tangled in the loopleaves for a long while, a time beyond time.

"Rod," she whispered, "are you sure it's all right?"

"What's right for you, is right for me. Can you live here now?"

Khral nodded, her fingers combing his hair. "I took in enough micromen to modify my chemistry so I can survive here. It wasn't fun," she admitted. "It was scary, after watching you go through it. But now they're okay. They're not a bad population; they're scientists, wanting to know how everything works."

"Curious, isn't it, how they always imitate their host."

"Don't people always grow into their

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habitat?" Khral shifted onto her elbow. "Rod, what about the colony?"

"The colony is changing. A couple of Brethren are joining us, and I'll be talking with them."

"The Spirit Brethren? Not the ones that dance before the moon?"

"Only at midsummer." He smiled. "Maybe I need to learn to dance, like 'jum."

"So long as it's with me."

"Are you sure? You know I have nothing to give you. Not even . . ." With a sudden thought, he plucked a broken-heart and slipped it around her finger.

In the caverns of Mount Anaeon, 'jum was showing the new Sharers how to feed the carnivorous plant that secreted the enzymes for their work. "They'll eat anything," she explained, "but they like hoopsnakes best."

A clickfly zoomed in to alight on her head. "Lightcraft landed outside," it clucked excitedly. "Visitor coming up mountain."

"Ushum?" Sarai called to her, looking up from the holostage where she tried to dissect the crossing-over of triplex chromosomes. "Ushum, can you see who it is? If it's anyone but Khral, send them packing. We're busy."

"Yes, Mother." She headed out to the mouth of the cavern. Blinking in the sun, she scanned the mountain across the valley. So many rays poked out between the crags, but now she had friends to help her count them. Down the slope cascaded the loopleaves, where little zoöids chased each other, clinging by their suckers. Whirrs soared up and down, carrying sisterlings from one world to another; at night, their messages would light up the singing-trees.

On the path below, a man in a cloak was climbing steadily toward the cavern. It was Brother Rod, come to see her again. 'jum smiled and waved, then she did a cartwheel, landing on her toes.

1 0 0 0 0 1 0 1, (be sure to tell him,) reminded the Dancing People. (Warn him about the poisons some of our foreign sisters are trying to spread, especially the alkaloids.)

I will, said 'jum.

(We're trying to spread peace and democracy among the worlds, but it's not easy.)

"That's a good trick, 'jum!" Brother Rod sketched a star in the air, and the stone at his neck glinted as if on fire. He caught her up in his arms, then set her down. "You're getting too big for me. You must be eating well."

'jum thought he looked well, too, not as sad as he used to. "Brother Rod, you need to watch out for the other sisterlings, the ones that still live in the tumblerounds. Some of them are not friendly."

"Are they hurting you?"

"Of course not." She took his hand. "My own sisterlings protect me. They are telling me the names of all the bad molecules to watch out for. Mother Sarai sends it all up to Station."

"And Station tells the rest of the world, wherever the micromen have got to. It's an important job you're doing." Brother Rod nodded. "Throughout the Fold, now, people are carrying worlds full of micromen. And, just like people, the Spirit has made more good than bad."

"They need our help," added 'jum. "They're mostly children." Children with elders, but no parents.

He looked out across the tops of the singing-trees, past the clouds and sun. A helicoid swooped down to catch something, its propellers humming. "There will be many more worlds to settle, now. And more of your own neighbors from Reyo have come to join us. So many changes—you would scarcely know the colony. But you will always have a home with us."

"This is my home now." 'jum nodded. "So many children. You were right, Brother Rod. This really is the Children Star."■

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Sonnet on First Learning the Definitive Role of Neurotransmitters in the Determination of Human Emotions

Oh, to be able just to phone in
Quantities of serotonin
When the limbic system's dripping
And the fight-or-flight scale's tipping

When those awful floods of nora-
Drenaline fill us with horra,
Neurologic intifada
In medulla oblongata

Can't we fax a soup tureen
Of Prozac or chlorpromazine
Up there, or somewhere in-between—
The thalamus perhaps? The spleen?

But no! Our Heart and Brain ignore us:
"Hormones do the feeling for us!"

—Eliot Fintushel

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THE REFERENCE LIBRARY Tom Easton

Overshoot, Mona Clee, Ace, $5.99, 388 pp. (ISBN: 0-441-00509-8).

Titan, Stephen Baxter, Harper, $23, 439 pp. (ISBN: 0-06-105259-0).

The Godmother's Web, Elizabeth Ann Scarborough, Ace, $19.95, 308 + x pp. (ISBN: 0-441-00503-9).

Dinosaur Summer, Greg Bear, Warner, $23, 325 pp. (ISBN: 0-446-52098-5).

The Soft Edge: A Natural History and Future of the Information Revolution, Paul Levinson, Routledge, $25, 257 + xviii pp. (ISBN: 0-415-15785-4).

Mind Matters: Exploring the World of Artificial Intelligence, James P. Hogan, Ballantine / Del Rey, $25, 370 + xvi pp. (ISBN: 345-41240-0).

Science Fiction on the Web

Heart of the Hero, Rickey R. Mallory, New Concepts Publishing (http://www.val uu.net/ncp), $3.99, 250 pp. (ISBN: none).

Books on Disk

The Monikins, James Fenimore Cooper, Mark Owings (3512 Chestnut Avenue, Baltimore, MD 21211), $1 (+ $1.50 s&h) (ISBN: none).

I spend a fair amount of energy glooming about the prospects for the next generation or two. Population is booming along with no sign of reversing course, the climate is warming, the rain forest is being burned, and much of the world seems headed for very warm soup indeed. Here at home—even if we seal the borders—we seem likely to suffer from shortages induced by high prices, chaotic weather, and perhaps chaotic international politics.

It's hard not to feel gloomy. If you have net access, you can download a QuickTime video clip that shows population growth from the year 0 to 2050 from http://www.physics.iastate.edu/gcp/issues/pop/growth.html. It puts on your screen a murky map of the globe with a yellow dot everywhere there is a cluster of a million people. Initially, the yellow shows entirely in India and China. Europe barely registers for the first thousand years. The Americas don't get a dot until about two hundred years ago. The map's dominating color becomes yellow in this century. By 2050 there is little else, and it is very hard to watch the change and remain optimistic.

Mona Clee displays a very similar attitude in her excellent **Overshoot.** The time is 2032, and the soup is bubbling. People are numerous, the climate has warmed, the seas are up, food is scarce, society is crumbling, and the octogenarian protagonist, Moira Burke, is fully aware that it could all have been prevented if only people had been able to see past their selfish short-term interests, their pocketbooks and comforts. She remembers an idyllic Texas childhood of clean air and water, a prolonged college life (she loved being a student), the discovery of environmental concerns, and finally moving on to a high-bracket legal career. Like so many others, she gave a few bucks to worthy causes such as the Sierra Club and got on with her life. She encountered the idea of the Earth as a sacred being—in

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the guise of the "Green Man" of myth and legend—but she found it spooky and turned her back. She was everywoman, everyman, recognizably us, and from her 2032 point of view—embarrassingly us.

In the late '80s, Moira met a visiting Chinese law professor who was quite enchanted by the wealth of information available in San Francisco. To her surprise, he was aware of and vitally concerned about the foreseeable ecocatastrophe. Together, they ran across the "Green Man" again, and she half-jokingly suggested that perhaps the dichotomy between those who see the world as a whole worth preserving and those who see only their own selfish interests is genetic. She introduced him to the Internet, and when the Tiananmen Square massacre drew him back to China at last, she lost him. Eventually Moira married money and gained a San Francisco estate. Come 2032, that estate is surrounded by electrified fencing and shared by a few other geezers. Together they farm the grounds, fighting drought and blistering sun to scratch a living from the mistreated Earth.

And one day, one of the geezers, a "witch" named Rhiannon, is surfing the Net when she stumbles across a message concerning a project called "Green Man." Someone is scheming to save the Earth, debating when to put the scheme into action, and they know Moira.

Who are they? What is the scheme? They won't say. They're waiting to see if the new Presidential candidate, who is saying all the right things about what to do to get out of the mess the Earth is in, can actually get elected, implement his program, and make any headway. But Moira's security force—a 'Nam vet in a wheelchair—is sure the vested interests will blow the poor chump away. When that indeed happens, and when terrorists release a plague to reduce the Earth's burden of humanity, and when . . .

The balloon is going up in a big way. The last minute is upon us. If anything is going to save our sorry asses, it's time to trot it out, silver bullets, white horse, and all, so that the reader may finally set the book down with some sense of satisfaction and promise.

And so it comes to pass. This is a successful parable of our world, our times, and our future. It quite eloquently assures us that if we are to have a future, we must implement drastic measures as soon as we can possibly manage.

Its greatest drawback is that I find Clee's solution to the problem too simplistic to believe. It's inescapably flawed (to my materialist mind) by mysticism. And it's probably not drastic enough.

Still, this one's well worth your attention.

Like many of you, I grew up on the space program of Mercury, Gemini, Apollo, and a host of fallen dreams. After Apollo, we were told and we believed, humanity would have space stations and Moon bases, Mars colonies and asteroid mines, O'Neill colonies, and maybe even in our lifetimes the first probes launched toward distant stars.

Didn't happen.

Blame politics. Priorities. Failure of vision.

Groan with dismay at a nation that turns daily ever more to religious and political extremism, at a people that seems to believe "vision" has more to do with auras, magic crystals, and channeling than with destiny.

Then pick up a copy of Stephen Baxter's **Titan**. The US is looking forward to the presidency of a man whose agenda includes the reinstatement of Aristotelian physics (remember the idea that the heavens are concentric spheres around the Earth?). China is putting its first astronauts into orbit and planning for the Moon. And the ill-maintained space shuttle *Columbia* is coming in for a landing when things go wrong. Most of the crew—including mission specialist Paula Benacerraf—ejects safely, but the effect on the space program is worse than after the *Challenger* disaster.

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America abandons its growing space station, grounds the shuttle fleet, and dives up its . . . hmph.

The dream is dead at last. Or is it? Paula meets Rosenberg, a JPL whiz kid with an idea: take what's left of the old gear, a moldering Saturn V, Apollo command modules, shuttles, etc., and cobble together a flight to Saturn's moon, Titan, from which the *Cassini* mission has just reported hints of life. It's the last hurrah of the Right Stuff, and against all the odds the project comes together and launches with its crew of five, including Paula and Rosenberg. Most of the crew even survive the long haul out to Titan, land, set up their base, and begin to explore.

Meanwhile, back home, the new president is in power, foreign aid and all trade treaties are dead, the UN has been booted out of New York, a wall is going up on the Mexican border, supply and retrieval missions for the Titan explorers have been canceled, the Northwest has seceded, China is rattling its sabers, and . . .

It's a cynic's nightmare (when you dive up your hmph, things very quickly get very dark and stinky). Fortunately, when all is well and truly lost, the reader notices that Baxter still has some pages to go. What he is about to salvage has very little to do with the human past. It is all about expansion, embracement of potential, the kind of vision we see in science fiction at its best and virtually nowhere else.

I'm not going to tell you enough to spoil it. You'll see what I mean when you read it, though it will take you a while to get to that point. Baxter has developed his tale slowly, step by step, in a manner that made me mutter more than once, "Get on with it!" But the payoff is there in both the terminal vision and in reflections on how we lost the vision we had in the sixties.

Enjoy.

When Elizabeth Ann Scarborough began her Godmother series (with *The Godmother,* 1995), I said she was writing "fairy tales for grown-ups, or fairy tales the way they was wrote an age and a half ago. Grim, gory, and ghastly, and the little dears would love them—if their parents would let them see the book." *The Godmother's Apprentice* (1996) was less grim and hence less appealing but it was surely more "suitable for children."

The third in the series, **The Godmother's Web**, is more like the second than the first in that respect. The fairy tales are still there and still getting mixed together (here Cinderella—Cindy Ellis—meets Spiderwoman, who taught the Navajo how to weave). They are also still confronting real-world problems, though those problems are no longer the direct translations of those of the fairy tales, as they were in the first book.

Cindy isn't too happy with her Prince Charming, Raydir Quantrill, a rock musician surrounded by sycophants who think just-folks, down-to-Earth, competent, direct, honest Cindy is just too-too quaint. Raydir takes off on a gig, and Cindy grabs an opportunity to run down to Navajo country to train a horse for trail riding. To do the job, she plans to take the horse on the trail, across the reservation country, but hardly has she begun when she encounters an oddly assured old lady clad in native costume who asks for a ride and promptly shifts the itinerary.

Before long, Scarborough has led her tale deep into the conflict between Navajo and Hopi, a web of mistrust, mistreatment, and family ties, and is guiding us on a tour of history, myth, culture, and modern despair fed by megacorp Earth-rapers, drug dealers, power-mongers, and more. Cindy plays relatively little part except as a vehicle for the reader's point of view. The true hero of the tale is Spiderwoman, another Scarboroughian godmother, and fairy godmothers being fairy godmothers, all turns out just fine in the end, with at least a chance for the major characters to live happily ever after.

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Scarborough's hand is assured, and she clearly knows Navajo-Hopi country and ways (she worked there once as a nurse). Scarborough fans should love it, and if you're looking for a gift for a middle-schooler, it's perfect. If you're a middle or high school librarian, don't miss it. You might even need more than one copy.

Have you ever wondered . . . ? Dinosaurs have been popular ever since they were first recognized for what they were: enormous, voracious, hellacious monsters that could have eaten a dragon for lunch and had room for a bevy of Andromedas and a couple of Perseuses to boot, and quite safely extinct. Indeed, all those stories of dragons might have been rooted in ancient discoveries of toothy skulls and Grandpa's mutterings of, "Oh, that, uh, well, we nailed the last of those suckers when I was a boy. And it was a job, let me tell you!"

So stories, myths, and legends galore. In due time, movies and plastic models.

But what if they had been more familiar? What if a few had lingered long past their day atop a Venezuelan tepui called El Grande until a Professor Challenger should discover them and bring back the word? People being people, it would follow as the night the day that a few intrepid and greedy souls should then bring a few back alive for exhibition in zoos and even circuses. And after a few years, after a few raptors had munched a few audiences and a few impresarios had lost their shirts, the "Ho-Hum" reaction would surely grow (as it did with the Space Program; see above) and the interest would fade.

So suggests Greg Bear as the premise for **Dinosaur Summer**. The tale begins with a boy, Peter Belzoni, whose father is a photographer of such irregular lifestyle that Mother left. Summer looms, and Papa Anthony hints of travel as he packs Peter up for a trip to Circus Lothar's last show. Papa will photograph the proceedings for the *National Geographic*. Peter, if he's game, can write a bit to go with the photos.

It soon emerges that Circus Lothar plans to repatriate its dinosaurs, including its rexish venator Dagger. The Belzonis will accompany the expedition by rail, ship, riverboat, and truck. With them will go a Hollywood film crew, the circus's dino trainer, and Ray Harryhausen, famed in our world for his early special-effects animation work. Several other characters also have our-world counterparts; they made a *King Kong* movie and a silent version of Sir Arthur Conan Doyle's *Lost World*.

Much of the adventure is set up for the inevitable disaster, when Dagger breaks loose and Peter, Papa, Ray, and others are trapped atop El Grande. Most of the good guys survive, of course, and Peter winds up with several very large growing-up steps behind him.

This one is for those who remember fondly the old movies and those responsible for their clunky special effects. It's also for modern kids who would love to return imprisoned animals to the wild, and would love that even better if the animals were as glorious as dinosaurs. It's a warm book, deeply rooted in popular culture but by no means trapped there.

Enjoy.

On-line educator, media theorist, and *Analog* contributor Paul Levinson teaches Communications at Hofstra University in New York and writes books such as **The Soft Edge: A Natural History and Future of the Information Revolution** in which he defies the critics of technology who insist that technology robs human life of its human character. On the contrary, says Levinson, the history of communications media shows the progressive restoration of human features—image, voice, immediacy, accessibility, interactivity—to the original communications technology (writing).

I oversimplify, of course, but that's it in a nutshell. Levinson like many others sets our propensity for language at the

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very center of human-ness. My own preference is to use our fondness for change, our tendency always to try to improve whatever we have, whether it be our tools, our languages, or our religions. It is in this that I think we differ most profoundly from the apes and other animals, and it can lead us in precisely the same direction that Levinson has gone. In technology, the tendency is to begin with a kludge. The gadget works, it does something new (or something old better), and it is definitely not user-friendly. You have to be an expert to make it behave, and it tends to serve the interests of those experts, or of those who hire them. This applies to personal computers, VCRs, airplanes, and communications media all the way back to writing. New technologies can indeed be as bad as the critics make them out to be. But give them time. New features get added, and the Morse-code telegraph becomes the telephone becomes radio becomes TV becomes the Internet becomes . . . What comes next? Perhaps artificial intelligence, though Levinson doesn't seem ready to go as far out on that limb as Hans Moravec or Jim Hogan (see below).

An interesting book, well worth the attention of those interested in the history, nature, and future of technology.

We know James P. Hogan for his science fiction, in which I have bemoaned his fondness for the extended expository lump. Indeed, I once called him "a modern master of the fictive info-dump," and now he proves the point with a non-fictive dump of superlative dimensions.

Mind Matters: Exploring the World of Artificial Intelligence is a thorough survey of the history of the concept of mind from Aristotle to cybernetics, and then of progress toward genuine artificial intelligence. He covers all the major bases, and he notes with wry amusement one of the grand peculiarities of the field: When computers were new and AI was first a dream, researchers drew up lists of things humans can do that everyone would call "intelligent." To achieve AI, they reasoned, all they had do was devise a machine that could do the same things. So they set to it, and before long they had attained remarkable success. However, as soon as they licked one item on the list, or seemed close to doing so, the critics said, "Oh, well, if a machine can do it, it can't really be 'intelligent.'"

The "things" that have provoked such responses include playing checkers, backgammon, and chess, and proving mathematical theorems, among other things. It is thus possible to suppose that we will one day have a machine that can do anything we can do with our brains, but no one will call it intelligent. Of course, it will then be impossible to say that we are intelligent, either.

Where will it all end? Hogan seems ready to agree with Vinge, Moravec, Minsky, and other optimists: Far sooner than most people even faintly suspect—perhaps by the time today's newborn is leaving college—there will be machines to call our mental equals.

Do you need convincing? Let Hogan do it. His book is an excellent introduction to a complex and fascinating topic.

Science Fiction on the Web

You've heard me grumbling that a lot of the fiction that appears in odd corners of the Internet isn't worth the fistful of electrons it takes to download it. This doesn't apply to operations like Ken Jenks's **Mind's Eye Fiction** (http://Tale.com/Titles.htm), which mostly reprints material previously published on paper and casts a critical editorial eye on the rest. Elsewhere the lack of that editorial eye is, shall we say, apparent.

But that is not to say that everything out there in silicon-land is electric dreck. The other day, Rickey R. Mallory dropped a copy of **Heart of the Hero** in my mailbox with a note blaming New

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Concepts Publishing (http://www.val-uu.net/ncp) for making it available to the downloading public.

And if that downloading public wants science fiction romance, they should love this one. The situation begins with Daniel White, young, rich, indulged, spoiled rotten, prone to violent temper tantrums when he does not get his way. Faced with mandatory public service in the space patrol, he grabs a young and comely chick out of the family aircraft plant, marries her, and tries desperately to get her preggers. Only that, you see, will get him exempted from MPS. But the conniving little bitch obstinately refuses to get pregnant, he explodes, tells Sweetie-Kee to be gone when he comes back, and ships out.

He returns a hero. An explosion nearly killed him, the surgeons put him back together, and here he is. But all he has of his previous life are a few photos and tapes. The rest is gone. He has amnesia. He's also undergone a drastic personality change, for he is no longer the bad boy he was.

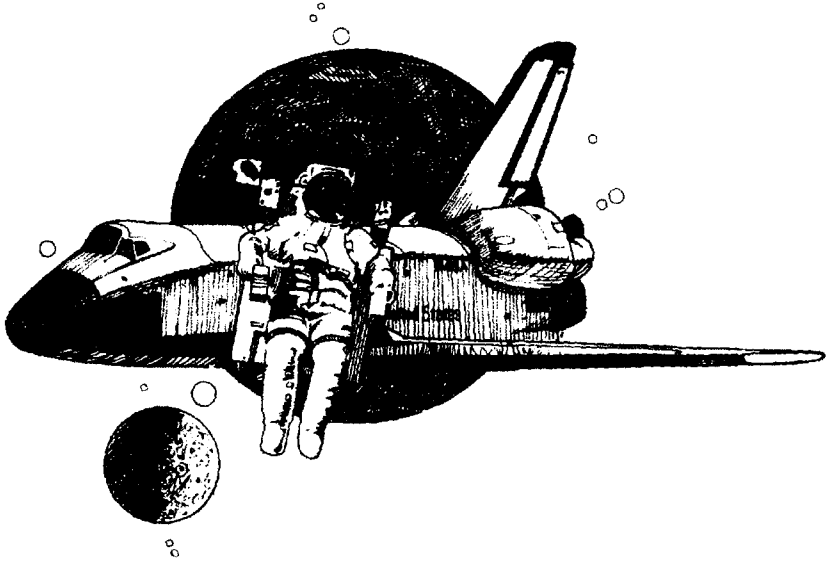
And Sweetie-Kee is waiting for him, all a-tremble with trepidation, thoroughly confused by the personality change, discovering that maybe, just maybe, this is a Danny White she can love even as Danny-boy settles his deep-rooted conflict with his abusive father, discovers the cause of the accident, and learns that Kee isn't such a bitch after all.

If you're the right reader, this is a real hankie-wringer.

If you're my kind of hardened cynic, you may find the smell of soap a little strong. Certainly the SF is less than essential to the story, for it could have been replaced with any war in at least the last hundred years.

Books On Disk

Mark Owings has finally finished his on-disk version of James Fenimore Cooper's **The Monikins** (1835), a long novel about the discovery of civilized monkeys. Style and content are surely of the period, but anyone who ever loved *Last of the Mohicans* will want to give it a shot. And you can't beat the price.■



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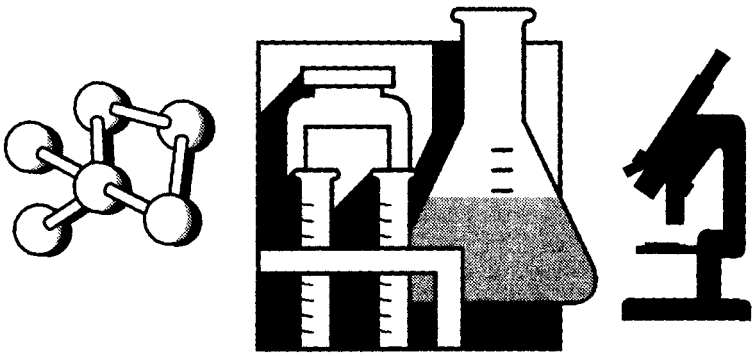
THE ANALYTICAL LABORATORY



Many thanks to all of you who voted in our annual poll on the previous year's issues—your most meaningful form of positive reinforcement for the authors and artists who do an especially good job of entertaining you. Your votes help your favorite writers and artists by rewarding them directly and concretely for outstanding work. They help *you* by giving us a better feel for what you like and don't like—which helps us know what to offer you in the future.

We have five categories: novellas, novelettes, short stories, fact articles, and covers. In each category, we asked you to list your three favorite items, in descending order of preference. Each first place vote counts as three points, second place two, and third place one. The total number of points for each item is divided by the maximum it *could* have received (if everyone had ranked it #1) and multiplied by 10. The result is the score listed below, on a scale of 0 (nobody voted for it) to 10 (everybody ranked it first). In practice, scores run lower in categories with many entries than in those with only a few. For comparison, the number in parentheses at the head of each category is the score every item would have received had all been equally popular.

NOVELLAS (5.00)
1. "Starsong," Timothy Zahn (5.48)
2. "Loose Ends," Paul Levinson (4.67)
3. "Billy's Bunter," Walter F. Cuirle (4.06)
4. "The Flowers That Bloom In the Spring," Wolf Read (3.68)

NOVELETTES (0.80)
1. "Trial By Ordeal," Grey Rollins (2.65)
2. "Ask Arlen," Maya Kaathryn Bohnhoff (2.28)

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3. "Easter Egg Hunt: A Christmas Story," Jeffery D. Kooistra (0.95)
4. (tie) "Gideon," Michael F. Flynn (0.92);
"Variations in DreamPaint," Marc Stiegler 0.92)

SHORT STORIES (0.67)

1. "Already in Heaven," Brian Plante (2.01)
2. (tie) "On the Application of Quantum Probability Tunneling to Improve Manufacturability of Printed Circuit Board Designs: A Case Study," Rick Cook & Peter L. Manly (1.21);
"Waiting for the Riddlers," Charles Sheffield (1.21)
3. (tie) "Last Exit Before the Final Frontier," Jeffery D. Kooistra (1.17);
"The Big One," James Van Pelt (1.17)

FACT ARTICLES (1.82)

1. "Cosmological Darwinism," Richard Meisner (3.52)
2. "Paradigm Shifty Things," Jeffery D. Kooistra (2.88)
3. "Just How 'Average' Is the Solar System?," Stephen L. Gillett, Ph.D. (2.61)
4. "Biology at the Extremes," Mark S. Lesney (2.39)
5. "Cold Fusion: The 'Miracle' Is No Mistake," Dr. Eugene F. Mallove (2.23)

COVERS (1.82)

1. January (for "Hubble's New Views of the Universe"): J. Hester & P. Scowen, Arizona State University and NASA (4.00)
2. October (for *O Pioneer!*): Bob Eggleton (2.55)
3. December (for "Crossing Chao Meng Fu"): George H. Krauter (2.39)
4. May: John Berkey (2.2)
5. November: Ron Walotsky (1.69)

Competition was again tight among novellas, in part because the field was so small. (Next year it may be bigger, thanks to our new and roomier format.) The other categories had clear first-place winners, the most dramatic being newcomer Brian Plante's short story "Already in Heaven" and that spectacular January cover, for which the Universe itself was in a very real sense the artist (but a lot of credit has to go to the folks who built and used the Hubble Telescope). But after first place, competition in some categories was so tight that we had multiple ties, and if we'd listed all novelettes with the five highest scores, we would had to list eight. Honorable mentions go to Amy Bechtel, Stephen L. Burns, and Bud Sparhawk.

We hope to get even more votes next year. Use e-mail or "snail mail," whichever you prefer, but please vote! (And please be careful to vote in the right category, as listed in the annual Index. Every year a few votes are wasted by being cast in the wrong category, and those simply can't be counted.)

H. J. C. Kunne, of the **Netherlands**, is this year's winner of a free one-year subscription in a random drawing from all ballots received. Next year that could be you—and the more votes we have, the more the results mean!

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BRASS TACKS

Dr. Schmidt:

One of the reasons I've always loved science fiction is the habit its best writers have of dropping little bits of commonsense information into their stories, even if it's not absolutely esssential to their storyline.

Rick Shelley did just that in the January issue, in his "Beacon" piece: it never would've occurred to me to wonder about haircuts and shaving in space, but now I'll never forget that it wouldn't be the best idea in the world, for all the reasons cited . . . and will thus have one more thing to carp about when exiting the cinema after having watched another Hollywood space oater!

Have to add, though, that Vincent Di Fate's illustration let down the side more'n a little: If an author goes to the trouble of devoting thirteen lines of text to a subject, is it too much to ask that the illustrator pay attention?

More bluntly: how does Angie (the female protagonist, just behind "our hero" in the otherwise-excellent artwork) keep her hair so trim?

A. Stephen Brewer
Makaha, Hawai'i
asbrewer@worldnet.att.net

To the Editor:

Just some quick comments on the January 1998 issue. I thought "Beacon" by Rick Shelley was an excellent story; just the kind of science fiction reading I enjoy. Also, Ben Bova's "The Question" was quite good.

Try as I might, I couldn't anticipate the ending. However, "The Eumenide" by H.G. Stratmann seemed to me completely out of place in *Analog* or any other science fiction magazine. The only thing remotely of this genre was that the woman had had some sort of brain or mind alteration. Please!

I know my interests are along the lines of deep space travel, alien contact, etc., so my views are biased. But please keep the stories you publish along those lines.

Finally, the cover art for this issue was excellent in both design and artwork.

Dennis D. Gaunt
Iowa City, IA
dgaunt@uhl.uiowa.edu

"Some sort of brain or mind alteration" is hardly trivial—and it's very science-fictional!

Dear Sir:

I found your January, 1998 editorial very interesting and well-written (your stuff usually is such). Based on the fiction authors listed in the 1997 index, where does *Analog: Science Fiction and Fact* fit? In the fiction category (novellas, novelettes, serials, short stories) you had a total of forty-seven authors (the shared authorships I counted as separate authors). Of those authors, ten had two or more of their writings published. Is the shift to "known" authors taking place herein also?

I discovered *Analog* in a barbershop in the early 1960's and read most of part two of a serial while waiting my turn. About five years later, I found the book and read the whole story. In fact, over the years, *Analog* has been one of my best

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sources to meet new authors. The fewer repeats of authorship in any given year, the better my chances of finding another author to like and whose works to follow.

C. HENRY DEPEW

As far as I know, Analog *has never bought stories just because their authors' names were well known, and has no intention of beginning to do so. Nor do I believe there has been any increase in the amount of "repeat appearances." Our policy has always been to buy the best stories we can get, regardless of where they come from or who writes them. Sometimes this means buying a story from an unknown; sometimes it means rejecting one from a "big name." We're just as delighted as you to find a new writer, but even more so if he or she turns out to produce many more good stories. There have always been some writers who were more prolific and/or consistent than others. (And how could you follow the works of somebody you've discovered if he or she were arbitrarily limited to one appearance a year?)*

Dear Stanley;

I have been a subscriber for about forty years and, coincidentally, told my wife to renew my subscription for another two years this week. In all that time this is my first letter to the editor. This isn't because I wasn't interested in the stories or editorials but that I am lazy. Now the Internet reduces the work to the point that I am finally replying to one of your writings.

I agree very much with your analogy regarding companies and ecosystems. My company has suffered through this cycle. Fortunately, several of the idea people still are having enough fun designing, building and selling products to stay around even with the heavy-handed management of money-motivated bosses.

There is though another reason why good companies fail and, ironically, I suspect *Analog* along with most of the rest of the publishing industry may succumb to it. That is replacement by a better way of accomplishing the primary objectives of the business.

I am referring to electronic publishing. With the dramatic increase in the capacity of the Internet, lowering of the cost of CDs and the quality of notebook PC displays, we will likely be receiving most of our literature in these forms very soon. This will probably be very disruptive of your industry but will probably eliminate the problem of the narrowing of the available choices.

The technology currently available is high quality displays for notebook computers. Last year reading "The Road Ahead" on my notebook screen wasn't very pleasant. This year my screen is as large as both pages of *Analog* at one time and plenty bright to view comfortably.

The next enabling technology was described to me on my way to work on NPR. ASDL is a subscriber loop phone technology about 50 times faster than current modem operation. They claim to be able to download the Encyclopedia Britannica in 30 minutes. Receiving one book or one magazine will be quicker than going out to the mailbox to bring it in.

One technology which is not here yet but will be key to increasing choice is the ability to pay by the page or by the document for information on the Internet in a cost-effective way. The setup cost of publishing a document on the Internet is much lower than that of a paper document but today there is no effective way for people to pay the author or publisher for single downloads.

Keep up the good work and consider preparing for the next wave of publishing technology. Unfortunately, www.analog.com is owned by Analog Devices Corp. but www.analogmag.com doesn't currently respond as a DNS entry.

BRUCE MCINTOSH
VICE PRESIDENT, TECHNOLOGY
ANALECT INSTRUMENTS, INC.

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Dear *Analog:*

Thank you all for once again providing a year's worth of stimulating and thought-provoking (not to mention entertaining) science fiction and speculation. Faced once more with the annual ritual of perusing the last twelve months' issues and choosing my "best of the best" for the AnLab voting, I find a field so rich that, for the second time in five years, I feel compelled to enclose an accompanying letter with my ballot form in order to recognize and honor some of the worthy "also rans."

The Novella category wasn't much of a challenge, since there were only four for the entire year—a simple matter of omitting my least favorite of the four, and then ranking the remaining three. "Billy's Bunter" and "Starsong" both could have been number one in my book, since both were so superb; in the end I gave the nod to the latter because I've always been a sucker for a good alien epic.

The Novelette category was far more daunting due to the larger number of quality entries. David Alexander and Hayford Peirce's "Finder's Fee" blew me away (that alien saga weakness popping up again) as did John M. Duffy and G. David Nordley's "From Every Opening Flower"—perhaps the most unsettling story I have read in the five years I've subscribed to *Analog.* The lasting images of pain as pleasure described in that work were truly nightmarish. You may notice both those choices were double-authored stories, perhaps a further demonstration of the Niven-Pournelle "two heads are better than one" syndrome. My middle choice—Maya Kaathryn Bohnoff's "Ask Arlen"—landed its high rank by virtue of sheer entertainment value. This might not be one that we'll still be talking about fifty years from now or that explodes the boundaries of the genre, but I can't remember when I had more out and out fun reading a story of that length. (Perhaps "Showdown at Hell Creek" but I'll have to give it some thought.) Please don't ever forget that, while scientific verisimilitude and plausibility are important, they don't mean a thing if the story's not enjoyable.

So what got left out? Two by Nordley alone, for starters: "This Old Rock" and "Crossing Chao Meng Fu" were both exemplary of the kind of scientific adventures one expects from *Analog* Bu "Rock" pulled off a particularly impressive feat: presenting the inspector as a villain at the start of the tale, then turning the tables so that we not only come to see her point of view as valid by story's end, but even sympathize with he position. An author who can expres both sides of a situation so compellingl is a true talent indeed . . . but then, wha should we expect from the creator c Trimus? Grey Rollins' "Trial by Ordeal was a very good story in spite of its in plausible premise: I cannot believe tha any crew member of an expedition mak ing first contact with an alien civilizatior even a lowly cook, would not have bee briefed sufficiently to avoid the mistak made in this story. That I still regard "Tr al" as an impressive achievement despit this flaw speaks to its overall quality otl erwise. Rick Shelley's superb "Safari" r minds us that science and new discove ies can be found where least expected and the surprise ending, if a bit abrup was quite a double-taker nevertheless Laurence M. Janifer's "Poems Are Mad by Fools Like Me" and David Phalen "Chasing the Idea Rat with My Bes Friend Jamie" both get points for th high quality of their writing. Other hor orable mentions: Peirce's "The Boxie R bellion", Michael Burstein's "Broke Symmetry", Stephen Burns' "Pitstop" (journey I for one would not care t take!), "Sam Boone's Dry Run", Mar Stiegler's "Variations in Dreampaint Bohnhoff's "Content with the Myster ous" (how does one reconcile the pe haps unexplainable with a scientific ou look?) and Kooistra's "Easter Egg Hunt Quite a year for novelettes!

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The Short Story category was a rather different matter in that two of the year's offerings—Wil McCarthy's "The Dream of Castles" and Brian Plante's "Already in Heaven"—were, in my opinion, so far out in front of all the others that the biggest dilemma was deciding which to place first and which second. Again, it could have gone either way. My third choice ended up being Alexis Glynn Latner's "The Life-Blood of the Land", although it could just have easily have been Burns's "The Wait" or Plante's "True Blue"—both stories which, upon rereading, hold up as nearly perfect. Fran Van Cleave's "Second Chance" gets kudos for its literary audacity and brazenness, while Steve Johnson's "Cargo" raises interesting questions about just what constitutes a person, and some of the legal and societal ramifications of that debate. All in all, a fine array of shorts, if not quite as packed as the Novelette category.

What more can I say? Except, Keep up the good work!

BRUCE HENNINGER

Stan,

Congrats on the realization of "MR. Robot"(February '98 editorial). I must shamefacedly admit that I had forgotton the original story.

On the rest of your piece, needless to say, I concur. Especially with the view that science should be fun. I'm not sure that we can ever convince those who solemnly count beans all their lives that there even is such a thing as fun, though.

Do you have an opinion as to the correlation between very high intelligence (a la Feynmann) and a great sense of humor? Seems to me I can think of quite a few such occurrences. But then there may be a few anti-correlations also.

Reminds me, many years ago I was told by a very intelligent and humor-gifted scientist at NASA that he had learned early on in his career as a supervisor, "Never joke with a subordinate. They may think you're serious." Which is all well and good in that context. Unfortunately, as Bud Sparhawk has discovered, some readers may also be "humor-challenged." To paraphrase the oldie, you can't amuse all of the people all of the time.

While I seldom find any SF these days that gives me the pleasure that I once felt, the story "Mortal Instruments" in this February issue was eminently satisfactory. The conclusion was *so* obvious—after the fact.

WARREN RAYLE
6880 COLUMBIA RD
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I am honored by your kind praise. Many things are obvious in hindsight, or upon objective reflection. My challenge in "Mortal Instruments" was keeping the reader subjectively involved in the story long enough to make the obvious appear as a surprise. I'm glad that, with you at least, I succeeded.

I also agree with your intelligence-humor correlation theory. Geniuses like me are tremendously funny—especially when bragging about ourselves! (Need I mention the tongue in my cheek?)

SHANE TOURTELLOTTE

Dear Stan:

In Shane Tourtellotte's story "Mortal Instruments" in the February *Analog*, the hero has his hearing electronically enhanced to give him perfect pitch only to find his advantage nullified when everyone else has the same procedure done. This was an entertaining take on the theme of technology vs. art, or technology as part of art, or where one ends and the other begins. The story was fun to read. I hope to see more from Shane. Now for the minor cavil: in our low-brow circles, at least, the more commonly addressed issue of technology is how much or what kind of amplification and/or electronic instruments can be allowed into traditional music without

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compromising its nature. We play for old-time contra dances using a sound system, and sometimes wonder whether the old way before electricity, with the band and caller filling a hall naturally, might still be the best way. An electronic ear seems a bit like a solution to a problem that doesn't exist. As a very amateur fiddler, I would say that the issue of intonation (making the note come out right) is less a matter of ear (you either hear it or you don't) and more a matter of making the fingers work right every time, which is a function of practice, practice, practice, alas. . . . No matter, the story idea still works fine.

But I wonder how many people noticed the nice illustration by Dell Harris, which shows some familiarity with fiddling in the way the bow is held, but shows the bow in the left hand! This would explain the hero's difficulty in getting to the top by itself, because playing left-handed is extremely difficult, with the high notes on the far strings. Maybe the picture was printed backwards? Thanks for making *Analog* a treat to find in the mail each month!

JACK PHILLIPS
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Dear Stan,

A couple comments on Stephen L. Burns's "Roll Over Vivaldi" (Feb. 1998).

This is speculating in advance of the data, since for all I know, the sk'rrli are a product of Mr. Burns's imagination (though they are quite reminiscent of some Marines I've served with), but it occurs to me that since their music resembles 20th century rap or aboriginal war chants, they probably found triaxon's selections from classic rock to be remarkably subtle, musically. They'd love the Scorpions—the only heavy metal band that actually sings.

Great job on the magazine, as usual.

RANDALL M. CLAGUE
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Dear Dr. Schmidt,

As I write this I think . . . "I should reread the story ("Roll Over Vivaldi," Feb. '98), so it is fresh in my mind," and you did it to me *again*! Even when I know what's going to happen, the punch line still puts me on the floor, laughing hysterically, until I'm out of breath.

Never mind that "they" did the same thing in *Back to the Future, Part Two*: this is still a master craftsman at work—laying the foundation, building the image, setting the mood, and then hitting you, the reader,. right between the eyes with the punch line. I really can see that trio of musicians playing with such *enthusiasm*!

Give this author a *bonus*!!

THOMAS LENON

Dear Dr. Schmidt,

No doubt you will receive many comments on The Alternate View piece in the February '98 issue, "Planet of the Geezers", by John Cramer. Being a molecular biologist myself, I was a little surprised to find Cramer, a physicist, delving into the subject of telomeres, telomerase, and their relation to aging. It was gratifying to see his caveat at the end of the piece, warning readers of his lack of experience in this field. Cramer did manage to present a fairly stimulating article in spite of this. However, there was one almost unforgivable error (actually repeated 3 times!) which prompted me (and probably many others) to write. I refer to the sentence on page 126: "A telomere is a special DNA structure with the repeating amino acid sequence TTAGGGTTAGGGTTAGGG. On page 127, a sentence begins "The DNA of every cell contains an amino acid structure . . ." and another sentence contains the phrase "part protein and part RNA amino acid sequence". Cramer has unfortunately gotten his biopolymers mixed up. Proteins are polymers of amino acids, while DNA is a polymer of 4 nucleotides whose chemical names begin with A, T, G, and C.

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It may be that Cramer's only mistake was relying too heavily on one source for his article. This is not to say that his single citation, Dr. Fossel's book, is at fault. I haven't read it so I can't comment further on it. However, there are other errors in Cramer's article which lead me to suspect they are also present in the cited source material. One is the attribution of the discovery of the telomere to Harley and Greider in 1990. I don't know the actual date, but telomeres (special structures at the ends of chromosomes) must have been discovered long before 1990. I believe Cramer is actually referring to the first description of telomerase, the ribonucleoprotein complex responsible for synthesizing the DNA component of telomeres, which was published by Greider and Blackburn in 1985.[1] Also, a telomere is not the "starting sequence for the enzymes that perform chromosome duplication". There are hundreds of "origins of replication" scattered throughout the chromosomes. However, due to the nature of DNA replication, the entire sequence of a double-stranded DNA molecule cannot be replicated. Some nucleotides at the end of one strand are lost during each round of copying. Therefore, telomeres have evolved to make sure no vital DNA sequences are lost, and telomerase acts to replace the lost telomeric sequences.

The role of telomeres and telomerase in aging is somewhat controversial. Premature aging syndromes such as Hutchinson-Gilford and Werner's syndrome do not recapitulate all the usual hallmarks of "normal" human aging. The specific genetic defect which causes Werner's syndrome actually has nothing to do with telomeres, but it is a mutation in an enzyme that probably acts to unwind DNA double-strands.[2] In other organisms such as fruit flies and worms, genes which affect metabolism and activity level have profound effects on life-span.[3] In mice, longevity has been found to be associated with genes of the immune system.[4] Nevertheless, telomere research is a fascinating and fruitful area, and the implications for cancer treatment, as described in Cramer's article, are perhaps the most exciting aspect of all.

[1] C. W. Greider and E. H. Blackburn, Cell 43, 405 (1985).
[2] C.-E. Yu, et al, Science 272, 258 (1996).
[3] C. Kenyon, et al, Nature 366, 461 (1993).
[4] V. Covelli, et al, J. Immunology 142, 1224 (1989).

THOMAS J. FIELDER
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ANAHEIM, CA 92804
tjfielder@earthlink.net

Dear Messrs. Silverberg & Cramer:

I am writing in reference to your articles on cloning (Reflections, *Asimov's*, Feb. '98) and aging (The Alternate View, *Analog*, Feb. '98). Having read both articles, a question occurred to me that may be important to both areas of research *How long are the telomeres on a cloned cell?* If telomeres are regenerated when an organism is cloned then the mechanism through which this is accomplished could be important to the aging research. If they are not, then unless those researching aging can learn how to regenerate them, we may be sentencing any clones to a foreshortened life. This would hinder the effectiveness of the research Mr. Silverberg mentioned as there would be a limited number of clone "generations" from a given organism. This also brings up an ethical question. At what age is someone too old to be cloned? The clone of a seventy-year-old person would be virtually guaranteed to have something similar to Hutchinson-Gilford syndrome. Has any research been done in this area?

CLIFTON NORTON

I had the same question when I heard reports about Dolly, the cloned sheep, and I asked a friend who works in molecular biology.

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He said that the cloning technique involves implanting cell donor DNA into an egg cell from which the resident chromosomes have been previously removed. It is believed that the egg environment will cause the telomerase coding in the DNA to be expressed (i.e., switched on) so that the telomerase enzyme is produced and can rebuild the donor chromosome's telomeres to maximum length.

However, as far as he knows, Dolly's telomeres have not actually been checked for length to verify this assumption. I read recently that there are now tests in progress to compare Dolly's DNA with that of her "clone-parent" to make sure she is a true clone, and perhaps such tests for telomere length will be a part of that procedure.

You are correct in suspecting that if the telomeres were not lengthened during the cloning process, the offspring would be likely to exhibit something like Hutchinson-Gilford Syndrome and die an early death.

JOHN G. CRAMER

Dear *Analog*,

In a letter to Anne McCaffrey I said:

"I am a forty-seven year-old professional independent American inventor, and one of the leaders of a three year-old movement in America of inventors who have banded together to protect and nurture inventors from those corporations who prey on them. The movement has nearly thirty Nobel laureates, about fifteen National Inventors Hall of Fame Inductees, many other people of stature, and thousands of aspiring inventors."

"A big reason that I invent is science fiction, which I discovered when I was in seventh grade. It taught me how to look at problems from different perspectives."

Mrs. McCaffrey responded with:

"By golly, you're one of the quiet ones that SF has influenced and I'm damned glad to hear from you. John W. Campbell, fabulous editor of *Analog* Magazine, would have loved to know that SF had that sort of effect on some young readers. He was certain it would."

This exchange made me realize that SF readers and writers needed to hear that SF has such an impact. I discovered science fiction in seventh grade. I became an avid reader of science fiction (and science fact, with *Analog* being my favorite SF magazine), which played a significant roll in the formation of my world view and ethical standards. SF helped create the mindset that makes me a prolific inventor across multiple disciplines. I firmly believe that science fiction is a great educational tool that allows concepts to be taught in a setting where the readers' or contemporary prejudices are not immediately triggered, allowing them to learn to look at problems from different perspectives. The thought process which SF can invoke is similar in many respects to the way a good inventor looks at problems, and produces solutions to those problems.

I am very involved with other professional inventors, for we have banded together to defend our rights. Large multinational companies have been doing their best to pass legislation which would make patents virtually unenforceable for independent inventors. Stopping them must be my primary activity *(see http://www.rjriley.com/multinationals/)*.

Time is my most precious commodity, and I do not have enough to get involved in many one-on-one exchanges with readers of SF. But I will make time for writers who wish to cover this topic for the masses *(see http://www.rjriley.com/media/)*.

RONALD J. RILEY
PRESIDENT,
PROFESSIONAL INVENTORS ALLIANCE
http://www.rjriley.com/pia
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UPCOMING EVENTS Anthony Lewis

2–5 July 1998
CONCEPT/WESTERCON 51 (West Coast Science Fantasy Conference) at Mission Valley Marriott, San Diego, CA. Writer Guests of Honor—Katherine Kurtz and Scott McMillan; Artist Guest of Honor—Sue Dawe; Special Guests—Forrest J Ackerman, Dr. Kary Mullis, J. Michael Straczynski; Fan Guest of Honor—David Clark. Registration—$55 until 31 May, $60 at the door; $20 supporting at all times. Info—ConCept, Box 15471, San Diego, CA 92175. Email—Ontell@io-online.com; URL—http://www.westercon.org/51/

10–12 July 1998
READERCON 10 (literary-oriented SF conference) at Marriott Hotel, Westborough, MA. Guests of Honor—Bruce Sterling and Lisa Goldstein; Memorial Guest of Honor—Leigh Brackett. Registration—$40 until 30 June, more at the door. Info—Readercon, Box 381246, Cambridge, MA 02238-1246. Email—zeno@mit.edu; URL—http://www.mit.edu/~zeno/readercon.html

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17–19 July 1998
LIBERTYCON 12 (Tennessee SF conference) at Radisson Read House, Chattanooga, TN. Guest of Honor—Lois McMaster Bujold; Artist Guest of Honor—Lubov; Special Guest of Honor—Wendy Webb; MC—Bob Tucker. Limited to 450 attendees. Registration—$25 until 1 June, $35 thereafter. Info—LibertyCon 12, Box 695, Hixson, TN 37343-0695. Email—libcon@cdc; URL—http://www.cdc.net/~libcon

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31 July–2 August 1998
RIVERCON XXIII (Louisville area SF conference) at Executive Hotel West, Louisville, KY. Guest of Honor—Harry Turtledove; Artist Guest of Honor—Kevin Ward; Fan Guests of Honor—Julee Johnson-Tate and Cris Tate; TM—Hal Clement. Registration—$25 until 15 July, $35 thereafter. Info—RiverCon XXIII, Box 58009, Louisville, KY 40268-0009. Email—RiverconSF@aol.com; URL—http://members.aol.com/raroehm/rivercon

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5–9 August 1998
BUCCONEER (56th World Science Fiction Convention) at Baltimore Convention Center and nearby hotels, Baltimore, MD. Guests of Honor—C. J. Cherryh, Milton A. Rothman, Stanley Schmidt, and Michael Whelan; TM—Charles Sheffield. Registration until 15 June 1998—$130 (£94); supporting $30 (£22); children +4 to 12—$65 (£47), children .75 to 4—FREE. [These are the latest posted rates as of the time this column went to press.] This is the SF universe's annual get-together. Professionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competition—the works. Info—Bucconeer, Post Office Box 314, Annapolis Junction, MD 20701. Email—bucconeer@bucconeer.worldcon. org; URL—http://www.bucconeer.worldcon.org

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13–16 August 1998
MARS SOCIETY FOUNDING CONVENTION at The University of Colorado, Boulder, CO. Speakers—Mike Griffin, Robert Zubrin, Chris McKay, Carol Stoker, Kim Stanley Robinson, Gregory Benford. Registration—$140 before 30 June, $180 thereafter. The purpose of the Mars Society will be to further the goal of the exploration and settlement of the Red Planet. URL—www. nw.net/mars ■

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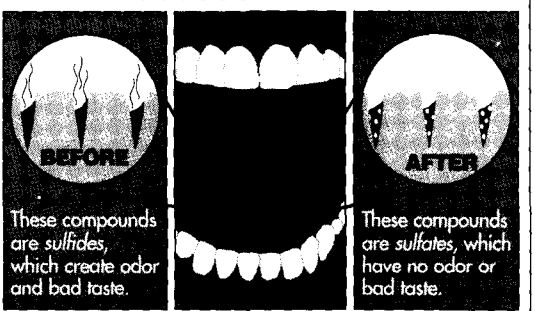
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TECHNOLOGY UPDATE

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Don't be fooled by high prices. No hearing device, no matter how expensive, can eliminate background noise, despite claims by the manufacturers. Crystal Ear does not promise miracles—just an affordable, sound solution to many common hearing problems.

Risk-free. Try Crystal Ear and hear what you've been missing. It comes with a 90-day manufacturer's limited warranty as well as our risk-free home trial. If you're not satisfied, return it within 30 days for a full refund.

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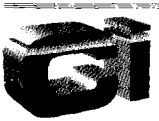

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